

4-1-2013

Full Issue (24.1, Spring/Summer 2013)

Journal of Transportation Management Editors

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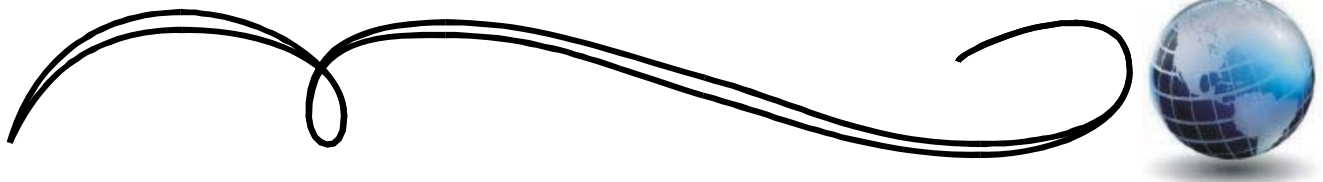
Recommended Citation

Taylor, John C. (Ed.). (2013). Full Issue (24.1, Spring/Summer 2013). Journal of Transportation Management, 24(1). doi: 10.22237/jotm/1364774880

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Journal of Transportation Management

Vol. 24 No. 1
Spring/Summer 2013



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ISSN# 1058-6199

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The primary purpose of the JTM is to publish managerial and policy articles that are relevant to academics, policymakers, and practitioners in the transportation, logistics and supply chain fields. Acceptable articles could include conceptual, theoretical, legal, case, and applied research that contributes to better understanding and management of transportation and logistics. Saying that, our policy requires that articles be of interest to both academics and practitioners, and that they specifically address the managerial or policy implications of the subject matter. Articles that are strictly theoretical in nature, with no direct application to transportation and logistics activities, or to related policy matters, would be inappropriate for the *JTM*. Articles related to any and all types of organizations, and of local to global scope, will be considered for publication.

Acceptable topics for submission include, but are not limited to, broad logistics topics, logistics and transportation related legal issues, carrier management, shipper management of transportation functions, modal and intermodal transportation, international transportation issues, transportation safety, marketing of transportation services, transportation operations, domestic and international transportation policy, transportation economics, customer service, and the changing technology of transportation. Articles from related areas, such as third party logistics, purchasing and materials management, and supply chain management, are acceptable as long as they are related to transportation and logistics activities.

Submissions from practitioners, attorneys or policymakers, co-authoring with academicians, are particularly encouraged in order to increase the interaction between groups. Authors considering the submission of an article to the *JTM* are encouraged to contact the editor for help in determining relevance of the topic and material.

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From the Editor...

Welcome to the Spring /Summer 2013 issue of the Journal of Transportation Management!

This issue of the *Journal* contains an article on dimensions of airline profitability, an article on trucking HOS rules, an article on paratransit, an article on trucking transportation options, and an article on a cross cultural assessment of the logistics/supply chain typology across three countries.

The first article investigates the ongoing evolution of the U.S. airline industry under deregulation, and utilizes the Service Quality Model to analyze long-term implications. The second article explores the history of hours of service regulations for U.S. motor carriers and investigates the changes to individual carrier profitability and productivity from the last major change to those regulations in 2003. The third article reports on a decision support system (DSS) that can aid mass transit authorities in evaluating paratransit service performance, and examines application of the model in the Massachusetts Bay Transit Authority (MBTA). The fourth article studies the topic of trucking industry transportation options and evaluates potential benefits, while considering obstacles and possible resolutions to these issues. The fifth article compares the three dimensions of the Bowersox Daugherty (1987) logistics strategy typology among five disparate countries and reports on the robustness of the Typology across these countries.

At the *Journal*, we are continuing to make a number of changes that will improve the visibility of JTM, and improve its position in the supply chain publishing world. These include registering and updating journal information with several publishing guides, placing the journal content with the EBSCO, Gale and JSTOR databases faculty have access to, and placing abstracts of all past journal articles on an open area of the DNA Journal web page. Full journal article PDF's continue to be available to subscribers on the web page at www.deltanualpha.org

I look forward to hearing from you our readers with questions, comments and article submissions. The submission guidelines are included at the end of this issue's articles and I encourage both academics and practitioners to consider submitting an article to the Journal. Also included in this issue is a subscription form and I hope you will subscribe personally, and/or encourage your libraries to subscribe.

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THE EVOLVING RELATIONSHIP BETWEEN AIRLINE PROFITABILITY AND PASSENGER SATISFACTION

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ABSTRACT

This paper examines the ongoing evolution of the U.S. airline industry under deregulation. After losing money for most of the past 35 years, carriers have made structural changes to their business models that have proven to be, at least in the short term, very profitable. After delineating these management actions, the paper examines their impact on passengers. The author utilizes the Service Quality Model to analyze the long-term implications of this new operating paradigm for passenger satisfaction. Based on this analysis the paper goes on to suggest several actions management could take to improve satisfaction. Finally, conclusions are offered and areas for additional research suggested.

INTRODUCTION

The U.S. airline industry has been in a state of instability since 1978. Deregulation, for better or worse, put the business of air transportation back into the hands of managers who were, after years of government regulation, free to decide what routes to serve, what fares to charge, and how best to meet the needs of their passengers while (hopefully) earning a profit. As the ensuing decades proved, the free market can be a tough place for an airline to survive in, let alone prosper. The 1980s saw a flood of new airlines entering the industry, often competing with the established (or legacy) carriers solely on the basis of low fares. By the latter part of the decade and into the 1990s, many firms realized that low price was difficult to sustain as a firm's only competitive advantage. Companies began failing in large numbers as the legacy carriers learned to leverage their route structures and higher service levels to attract passengers while selectively lowering prices to compete with new entrants. Unfortunately, the inability to adapt to an open market also quickly claimed some of the nation's oldest airlines: Braniff International in 1982, Western Airlines in 1986, and both Eastern and Pan Am in 1991.

The business environment became even worse in the 2000s as carrier managers were forced to

deal with rising fuel, security, and general operating costs while confronting an extremely price-sensitive customer base demanding the impossible: low fares and high service levels. As shown in Table 1, the volatility in annual industry earnings from 2000-2011 was staggering.

However, by 2009 there were clear signs that U.S. airlines had made structural changes to their business models that could very well signal a permanent turnaround in their fortunes. After delineating these management actions, this paper will examine their impact on passengers utilizing the Service Quality Model (Zeithaml, Berry and Parasuraman, 1985) to look at the long-term implications of this new operating paradigm for passenger satisfaction. Finally, conclusions will be drawn and areas for additional research suggested.

A NEW REALITY

This section of the paper reviews a number of management actions that have shaped the industry since deregulation, and the impact of those actions on passengers.

TABLE 1
OPERATING PROFIT/LOSS FOR U.S. CARRIERS 2000-2011

Year	Operating Profit/Loss (Thousands of Dollars)
2000	7,014,004
2001	-10,318,784
2002	-8,565,745
2003	-2,092,538
2004	-1,489,673
2005	447,623
2006	7,639,841
2007	9,343,743
2008	-3,350,129
2009	2,334,971
2010	10,516,933
2011	7,121,315

Source: Research and Innovative Technology Administration
Bureau of Transportation Statistics F41 Schedule P12 Data
http://www.transtats.bts.gov/Data_Elements_Financial.aspx?Data=6

Management Actions

Management actions that have been stood out in recent years are discussed next and could be grouped into categories that include mergers, fees, flight reductions, fares, and fuel costs.

Mergers

While airline mergers have been common since the beginning of deregulation, they reached a critical mass in the past decade. As seen in Table 2, many of the so-called legacy carriers that were household names in 1978 have disappeared, either because they failed outright, or merged with the survivors. In fact, American and US Airways are contemplating a union that would arguably be the last one possible without running afoul of anti-trust laws (Spector and Carey, 2012). As a result of this consolidation, the companies have been able to impose various fees on passengers, reduce the number of flights and raise fares, actions that have significantly improved their profitability but adversely

affected customers. Each of these business decisions will be discussed in more detail below.

Fees

The airlines have gradually imposed a myriad of charges for amenities and services that historically had been included in the fare, a process known as un- or de-bundling. Beginning with checked luggage and reservation charges, there are fees now for booking a ticket over the phone, reserving certain seats, boarding an airplane early, printing a boarding pass at the airport, and even carrying on a bag (Garrow, Hotle and Mumbower, 2012). The profit potential becomes obvious after examining a hypothetical airplane carrying 100 passengers each paying an average domestic \$146 fare (\$292 round-trip) and noting how many customers, on average, are needed to cover the cost of the flight. Twenty-nine people will be required to meet fuel expenses, with another 20 covering personnel salaries; 16 passenger fares will be allocated to ownership costs, 14 to

TABLE 2
MAJOR U.S. AIRLINES IN 1978

Airline	Current Status
American	Still operating, exploring merger with US Airways ⁱ
Braniff	Ceased operations, 1982 ⁱⁱ
Continental	Merged with United, 2010 ⁱⁱⁱ
Delta	Still operating
Eastern	Filed for Bankruptcy, 1989 ^{iv}
National	Merged with Pan Am, 1980 ^v
Northwest	Merged with Delta, 2008 ^{vi}
Pan Am	Filed for Bankruptcy, 1991 ^{vii}
TWA	Merged with American, 2001 ^{viii}
Western	Merged with Delta, 1987 ^{ix}
United	Still operating

(Endnotes)

ⁱ Carey, Susan. "AMR, US Airways Talks Draw Closer," *The Wall Street Journal*, September 1, 2012, p. B3.

ⁱⁱ <http://www.braniffpages.com/syhistory.html>

ⁱⁱⁱ <http://www.chicagotribune.com/business/breaking/chi-united-continental-pilots-vote-to-authorize-strike-20120718,0,2280435.story>

^{iv} http://articles.latimes.com/1989-03-10/news/mn-1205_1_eastern-airlines

^v <http://www.nationalsundowners.com/about/history.php>

^{vi} <http://www.northwestairlines.com>

^{vii} http://articles.latimes.com/1991-01-08/news/mn-8037_1_united-airlines

^{viii} <http://stlouis.cbslocal.com/2011/04/09/american-airlines-buyout-of-twa-completed-ten-years-ago-today/>

^{ix} http://deltamuseum.org/M_Education_DeltaHistory_Facts_Family_Tree_Western_Timetable.htm

various government fees and taxes, and 11 to maintenance. Nine tickets will cover "other" costs such as catering, delivering lost bags, rental of airport facilities, marketing, legal fees, etc. With 99 passengers accounted for, that leaves only one covering profit. Ancillary revenue, on the other hand, supplements the flight by \$18 per person or \$1800 total (McCartney, 2012a). The results speak for themselves. In the first three months of 2012, U.S. carriers earned \$816 million in baggage fees and \$631 million in reservation change fees (Jones, 2012), all of which are imposed along with the various government taxes and fees collected as additions to the fare.

Flight Reductions

For years, airline managers realized they were offering too many seats, but competitive

pressures made it impossible for any single carrier to reduce their capacity for fear of ceding business to a competitor. However, industry consolidation has reached the point where the remaining airlines have been able to successfully pull back on the number of flights they operate, with a concomitant positive impact on load factors. As shown in Table 3, the number of flights offered by U.S. airlines rose steadily from 2000, peaking in 2005, and then falling to their lowest level in 2011. Load factors, on the other hand, have trended upward for the entire decade, also reaching their peak at slightly over 82% in 2011. The end result is fewer aircraft carrying more passengers, which is good news for the firm, a fact confirmed in a recent study by Lin utilizing Activity-Based Costing and Data Envelopment Analysis to illustrate the power of lowering costs and raising load factors on schedules services (Lin, 2012).

TABLE 3
OPERATING DATA FOR U.S. CARRIERS 200-2011

Year	Passengers Moved (All Airports)	Flights (All Airports)	Load Factor (Passenger Miles as a Percentage of Available Seat-Miles)
2000	665,486,803	8,493,297	72.33
2001	621,369,048	8,221,751	70.00
2002	612,777,682	8,675,945	71.78
2003	644,234,973	10,136,163	73.46
2004	700,230,727	10,699,663	75.48
2005	735,104,668	10,825,881	77.64
2006	741,098,199	10,521,442	79.23
2007	766,626,582	10,671,436	79.93
2008	740,460,933	10,202,004	79.54
2009	701,164,455	9,542,320	80.41
2010	717,744,056	9,499,044	82.07
2011	728,351,972	9,455,032	82.10

Source: Research and Innovative Technology Administration
Bureau of Transportation Statistics F41 Schedule P12 Data
http://www.transtats.bts.gov/Data_Elements_Financial.aspx?Data=6

Fares

Table 4 shows average U.S. domestic fares in current and constant dollars from 1995-2011. In current terms, fares have risen 24.5% over the period from \$292 in 1995 to \$364 in 2011; while in real dollars, however, fares have actually fallen almost 16% since 1995. Year-to-year fluctuations, while generally upward, have been relatively modest with the largest annual change a 10.4% drop in 2009. In line with the earlier discussion regarding industry flight reductions, the 8.3% price increases in both 2010 and 2011 may indicate consolidation is having a positive impact (from management's point of view) on prices as well. Unfortunately, passengers are having an increasingly difficult time determining how and when to buy. The proliferation of online booking options usually beginning with lowest price can easily confuse a buyer. In fact, even airline websites offer fares that, while

appearing low, may involve ridiculously circuitous routings that can more than double the elapsed time of the trip.

Fuel Costs

Coping with rising fuel costs is an on-going challenge for carrier management and the impetus for many of the strategic changes already discussed. As shown in Table 5, double-digit year-to-year increases, both in the United States and abroad, became the norm in 2003, although the volatility inherent in oil prices made managing these costs even harder. For example, fuel was 46% more expensive in 2008 than in 2007, but in 2009 the price fell 38% only to rise again 18% in 2010. Rather than increasing fares, surcharges are often used to recoup higher fuel costs because they can be easily manipulated as market conditions change. In addition, the passenger perceives that the fare

TABLE 4
ANNUAL U.S. DOMESTIC AVERAGE ITINERARY FARE IN
CURRENT AND CONSTANT DOLLARS

Year	Average Fare (\$) (in Current Dollars)	Percent Change from Previous Year (in Current Dollars)	Cumulative Percent Change from 1995 (in Current Dollars)	Average Fare (\$) (in 1995 Dollars*)	Percent Change from Previous Year (in 1995 Dollars*)	Cumulative Percent Change from 1995 (in 1995 Dollars*)
1995	292			292		
1996	277	-5.3	-5.3	269	-8.0	-8.0
1997	287	3.8	-1.7	273	1.5	-6.7
1998	309	7.6	5.8	289	6.0	-1.1
1999	324	4.7	10.8	296	2.5	1.4
2000	339	4.7	16.0	300	1.3	2.7
2001	321	-5.4	9.7	276	-8.0	-5.6
2002	312	-2.6	6.9	265	-4.1	-9.4
2003	315	1.0	7.9	261	-1.3	-10.6
2004	305	-3.2	4.5	246	-5.7	-15.7
2005	307	.6	5.2	240	-2.7	-17.9
2006	329	6.9	12.4	248	3.6	-15.0
2007	325	-1.0	11.3	239	-3.7	-18.2
2008	346	6.5	18.5	245	2.6	-16.1
2009	310	-10.4	6.2	220	-10.1	-24.5
2010	336	8.3	15.0	235	6.5	-19.6
2011	364	8.3	24.5	247	4.9	-15.6

Source: Bureau of Transportation Statistics, http://www.bts.gov/programs/economics_and_finance/air_travel_price_index/html/annual.html

* Rate calculated using Bureau of Labor Statistics Consumer Price Index.

Note: Percent change based on unrounded numbers.

TABLE 5
AIRLINE FUEL COST AND CONSUMPTION 2000-2011
(U.S. CARRIERS – SCHEDULED)

Year/ Percent Change	Domestic Consump- tion (Million Gallons)	Domestic Cost (Million Dollars)	Domestic Cost per Gallon (Dollars)	International Consumption (Million Gallons)	International Cost (Million Dollars)	International Cost per Gallon (Dollars)	Total Consumption (Million Gallons)	Total Cost (Million Dollars)	Total Cost per Gallon (Dollars)
2000	13,903.7	10,810.6	.78	5,122.5	4,387.8	.86	19,026.2	15,198.4	.8
2001	13,112.1	10,024.7	.76	4,955.6	3,989.5	.81	18,067.6	14,014.2	.7
% change over 2000	-5.69%	-7.27%	-1.67%	-3.26%	-9.08%	-6.01%	-5.04%	-7.79%	-2.9%
2002	12,287.2	8,602.9	.70	4,571.6	3,334.8	.73	16,858.7	11,937.7	.7
% change over 2001	-6.29%	-14.18%	-8.42%	-7.75%	-16.41%	-9.39%	-6.69%	-14.82%	-8.71%
2003	12,417.0	10,315.4	.83	4,451.0	3,838.2	.86	16,868.0	14,153.7	.8
% change over 2002	1.06%	19.91%	18.65%	-2.64%	15.10%	18.21%	.06%	18.56%	18.5%
2004	13,380.0	15,141.2	1.13	4,764.7	5,690.7	1.19	18,144.7	20,831.9	1.1
% change over 2003	7.76%	46.78%	36.22%	7.05%	48.26%	38.5%	7.57%	47.18%	36.83%
2005	13,284.2	21,682.9	1.63	5,040.3	8,600.8	1.71	18,324.5	30,283.7	1.6
% change over 2004	-.72%	43.20%	44.24%	5.78%	51.14%	42.87%	.99%	45.37%	43.95%
2006	13,019.4	25,105.4	1.93	5,220.3	10,535.2	2.02	18,239.7	35,640.6	1.9
% change over 2005	-1.99%	15.78%	18.14%	3.57%	22.49%	18.27%	-.46%	17.69%	18.24%
2007	12,998.8	26,889.9	2.07	5,428.0	11,685.0	2.15	18,426.8	38,584.9	2.0
% change over 2006	-.16%	7.15%	7.32%	3.98%	10.91%	.67%	1.03%	8.26%	7.16%
2008	12,469.4	37,194.9	2.98	5,508.9	17,773.5	3.23	17,978.4	54,968.4	3.0
% change over 2007	-4.07%	38.27%	44.14%	1.49%	52.11%	49.87%	-2.43%	42.46%	46.01%
2009	11,147.4	21,168.5	1.9	5,086.6	9,514.4	1.87	16,234.0	30,682.9	1.8
% change over 2008	-10.60%	-43.09%	-36.34%	-7.67%	-46.47%	-42.02%	-9.70%	-44.18	-38.18%
2010	11,056.2	24,791.7	2.24	5,246.4	11,626.7	2.22	16,302.6	36,418.4	2.2
% change over 2009	-.82%	17.12%	18.08%	3.14%	22.20%	18.48%	.42%	18.69%	18.19%
2011	10,863.6	31,345.1	2.89	5,521.1	15,536.3	2.81	16,384.7	46,881.4	2.8
% change over 2010	-1.74%	26.43%	28.67%	5.24%	33.63%	26.98%	.5%	28.73%	28.08%

Source: Bureau of Transportation Statistics, <http://www.transtats.bts.gov/fuel.asp?pn=0&display=data1>

has not risen, but the price of fuel has, which is beyond the company's control.

Impact on Passengers

The above airline practices have had a major impact on passengers. These impacts are discussed next and relate to mergers, fees, flight reductions, and fares.

Mergers

There are now fewer U.S. airlines to choose from, especially for overseas travel. As the survivors rationalize their routes and realign their hubs, multiple stop flights are becoming more common as passengers hopscotch from hub to hub over what used to be a one stop trip. Frequent Flier programs have been merged, with negative implications for virtually everyone. Delta Airlines, for example had three levels of elite frequent fliers prior to their merger with Northwest: Silver, Gold, and Platinum. A fourth tier, Diamond, was added after the merger which had the practical effect of shifting the existing categories downward. In addition, the sheer number of members, especially in the lowest elite tiers, now works against receiving an upgrade to business class or even claiming an award ticket (McCartney, 2012b). On a recent domestic flight, there were 38 coach passengers on the wait list for a seat upgrade on a 120 seat aircraft. Needless to say, the chances of anyone below Platinum receiving an upgrade were virtually non-existent. This dilution of their loyalty programs should be viewed with concern by managers, given the findings of a recent study that frequent flier programs are strongly associated with behavioral loyalty for business and frequent travelers, the companies' most profitable customers (Dolnicar et al., 2011).

Fees

Supplementary fees have arguably become the most frustrating aspect of flying today. The 2012 American Customer Satisfaction Index

rated airlines in the bottom three among 47 industries evaluated for customer satisfaction (Carey, 2012). Similarly, the JD Powers and Associates 2012 North American Airline Satisfaction Study found that, after two years of consecutive industry improvements, overall passenger satisfaction declined slightly, with costs and fees (specifically related to baggage) playing a key role in that reduction (autos.jdpower.com., 2012). Carriers have realized the profit potential inherent in charging for ancillary goods and services, and they have become more creative in determining what they can demand a fee for. Customers have been paying for tangibles such as food, beverages, paper tickets, headsets, pillows and blankets for some time. Given that air transport is primarily a service industry, future revenue opportunities lie in charging for intangibles, several of which have already been mentioned. Other items under consideration by various airlines include fees for aisle and window seats, which would significantly impact, for example, families wanting to sit together (Mayerowitz, 2012), and allowing passengers to pay for the privilege of exiting the airplane early (Jones, 2012). Indeed, customers can be forgiven for wondering where the upcharges will end. One study suggested adopting passenger weight as a major fare determinant (Bhatta, 2012). Given the direct relationship between aircraft operating cost and weight, charging a 200 pound person a higher price than a 100 pound individual does not seem unreasonable. Irish low-cost carrier Ryanair has a truly imaginative CEO who has, in the past, suggested charging passengers to use the toilet on-board the aircraft (Massey, 2012). While most critics view his comments as a publicity stunt, such a move does not seem beyond the realm of possibility.

There are also fees and taxes added to the ticket price that are required by the U.S. and foreign governments. The total fare quoted to the customer includes all of these and they are easily identified if the buyer cares to see them. Checking an economy fare from Orlando to

Tokyo shows a base fare of \$1127.40 plus \$724.90 in taxes and carrier-imposed fees for a total charge of \$1852.30. Examining those figures in more detail shows the carrier-levied charges constitute \$654 with the remaining \$101.90 spread out over seven various charges imposed by the U.S. and Japanese governments. As stated by the airline, these non-government costs represent “Carrier-imposed surcharges stated separately from the base fare on some international itineraries” (Delta, 2012). A logical assumption would be that at least part of it is to cover higher fuel costs, but there is really no way to tell.

There are, from the passengers’ standpoint, several problems with these types of fees. First, once they are imposed, they rarely go away. Second, the relationship between fares and these charges is unclear so the danger is that fares can be raised by more than the amount needed to cover the fee(s), essentially turning them into a money-making proposition. As an example, fuel surcharges by U.S. airlines have risen 53% since April 2011, while the price of fuel has increased 24% (Martin, 2012a). Finally, as nations grapple with future societal issues that embrace the airline industry (security, emissions, economic development, etc.), fees are likely to proliferate. For example, the European Union’s (EU) emissions trading system (ETS) went into effect for airlines on January 1, 2012, and applies to all carriers regardless of nationality operating flights to or from Europe (Wall Street Journal Editorial, 2011). Delta, United-Continental, American and US Airways immediately imposed a \$6 per round trip ticket surcharge on European routes, although some estimates suggest that complying with the program could cost the airlines about 3% of the fare per passenger (Jansen, 2012). The airlines did not immediately acknowledge that the \$6 increase was attributable to ETS program compliance, nor is it explicitly reflected on any website. Perhaps it is included in the Carrier Imposed Surcharge discussed earlier.

Flight Reductions

As was mentioned earlier, fewer and fuller flights have been a direct result of industry consolidation, a clear benefit to the carrier as every departure is virtually guaranteed to be, for all practical purposes, full. However, passengers do not typically share management’s enthusiasm for full aircraft. The boarding process alone becomes more problematic and takes longer to complete. Because so many people want to carry on larger bags, securing overhead storage space becomes very important. Most airlines have historically required passengers to follow some form of zone policy to smooth the boarding process: business class passengers go on first, followed by those seated in Zone 1, then Zone 2, etc. Today, however, after business class, there are multiple categories allowing various elite passengers to board before even getting to Zone 1 (which used to include the elite customers). The inevitable result is that overhead space fills before late-boarding passengers can be accommodated, thus disrupting the boarding process as they try and figure out where to stow their bag(s). Ultimately, some luggage must then be checked, but the fee cannot be collected at this late stage, so these customers do not pay when others have.

Fares

As explained earlier, there are clear indications that fares will continue to increase: seat capacity has been reduced, load factors are increasing and fuel costs remain highly unstable. Unfortunately for management, consumers do not really differentiate between fares and fees; they are, for all practical purposes, one in the same so that, to consumers, raising the latter means the former increases as well. As explained earlier, Delta provides a complete breakdown of fees which are added to a base fare. For a comparable route, US Airways quotes a base fare almost double that of Delta, but with a much smaller amount listed for taxes and fees (US Airways, 2012). In both cases the total customer cost is essentially the same. With

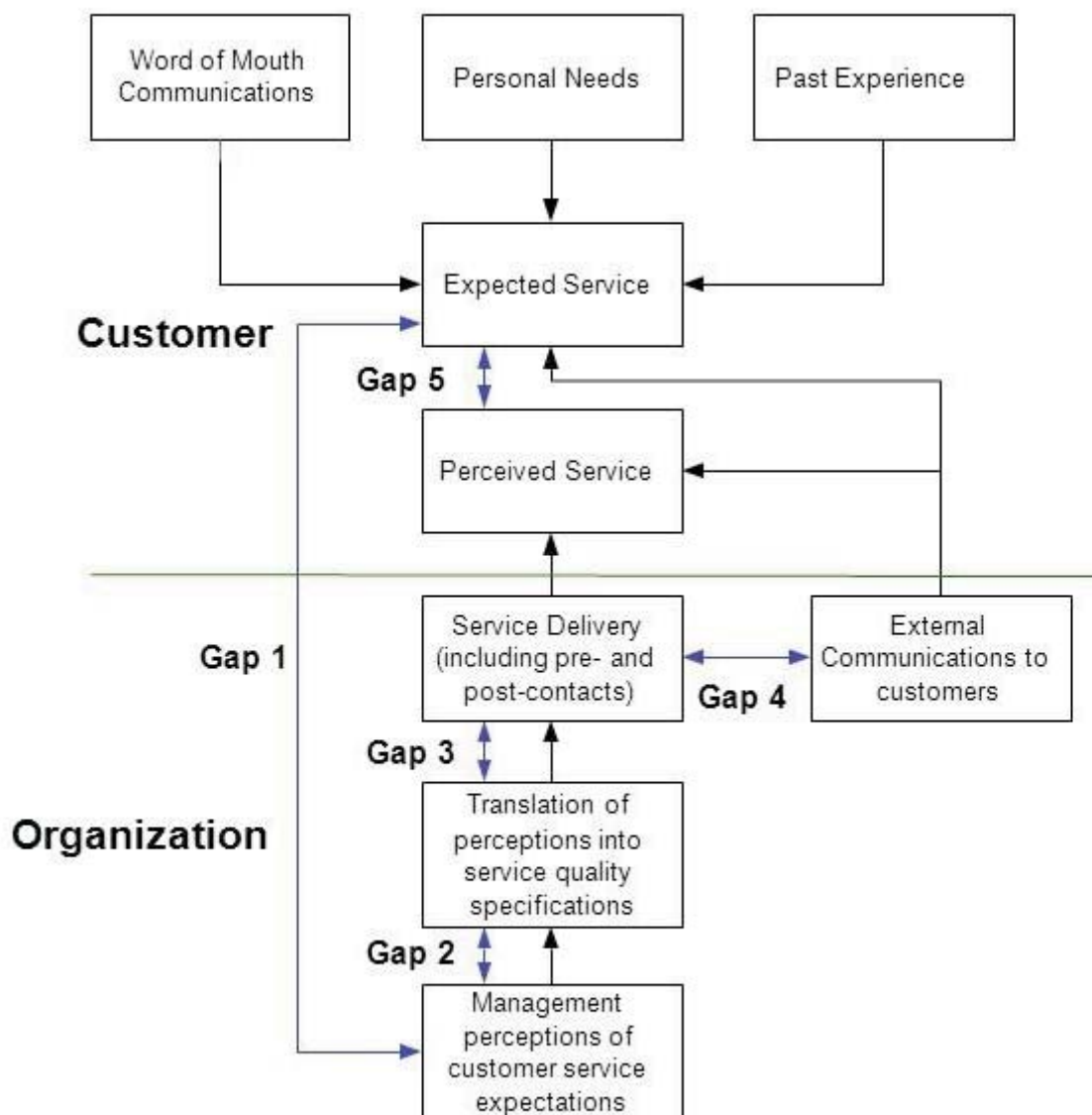
upward pressure on both fares and fees, customers should be able to tell what component of each goes into the total cost they pay.

Summary

Clearly, airlines, like any other enterprise, must make money in order to survive and grow. Hopefully, managers are able to earn profits

from satisfied customers through their return business. After years of losing money, carriers are profitable again and seem poised to remain that way. But, if the previous discussion is any indication, virtually all of the actions taken to turn the businesses around, while successful in that regard, have shifted costs to passengers, reduced value-added services, and generally diminished the travel experience. In the next

**FIGURE 1
SERVICE QUALITY MODEL**



Source: Zeithaml, V.A., Berry, L.L., and Parasuraman, A., "Communications and Control Processes in the Delivery of Service Quality," *Journal of Marketing*, vol. 52, April 1998, p. 36

section, the Service Quality Model will be introduced to evaluate the longer term implications of these actions for both airline profitability and customer satisfaction.

SERVICE QUALITY MODEL

Because airlines are a service industry, the Service Quality Model depicted in Figure 1, is useful in illustrating how customer dissatisfaction can develop. Ignoring the arrows, the model represents the basic marketing process. That is, the chart is divided into two parts: customers are on the top, management on the bottom. Managers must first learn what customers expect in terms of service. Once management understands their customers' needs they can put together a service mix that will satisfy them. The customer benefits offered by the firm must be communicated to the buyers so that they understand why the firm provides more value than a competitor. That value must then be delivered to the customer in a way that meets their expectations. If the service the buyer receives meets their expectations, then they will be satisfied and the firm will profit. The arrows, or Service Quality Gaps, depicted in the model represent potential sources of customer dissatisfaction. Each of these Gaps will be explained below.

Gap 1: Understanding Customer Needs

Gap 1 illustrates the situation when management does not really understand their customers' needs. For example, managers might assume that passengers desire an inflight amenity which, in fact, they do not. Either insufficient market research has been performed or the results have been misinterpreted. Whatever the reason, management cannot hope to design and deliver quality service if they do not completely understand what their customers want.

Gap 2: Satisfying Customer Needs

Gap 2 opens when management does know what their customers desire (i.e. Gap 1 does not exist)

but is unwilling or unable to satisfy their needs. Perhaps customer expectations are too high or the firm simply lacks the resources to adequately meet them. Alternatively, customers may not be sufficiently aware of their "true" travel needs so that their stated desires are inconsistent with their actual requirements. Again, the service mix developed and offered to customers does not meet their expectations, and dissatisfaction results.

Gap 3- Staff-Passenger Interactions

Gap 3 is an especially troubling one because it signifies the situation where managers know what customers want and have developed a high-value offering to meet those needs, but that service is poorly delivered. For example, the passenger may be satisfied with the airline's reservation and ticketing process, but the gate agent is rude and refuses to change a seat assignment. Thus, the customer is dissatisfied with the whole encounter (see Gap 5). Often the difficulty is that the only carrier employee the passenger comes into contact with is the flight attendant, ticket agent, or customer service representative. If this person is upset for some reason or simply disinterested, he or she can undermine all of management's best efforts to provide quality service.

Gap 4 – Execution of Services

Gap 4 is created when the organization promises something to the customer that is subsequently not provided. For example, the airline promises that passengers will receive their checked bags once the aircraft arrives at the destination airport. Unfortunately, for a variety of reasons, bags are misrouted or lost, and do not arrive with the customer. While most people are reunited with their luggage relatively quickly, passenger resentment for this situation has increased with the arrival of baggage fees which are typically not refunded when a bag is mishandled, leading to customer dissatisfaction (Gap 5).

Gap 5 – Performance vs. Expectations

Gap 5 is the most critical opening, because it reflects a situation in which the service received by customers is different than what they expected. The buyer is dissatisfied because their actual experience was less than what they anticipated. On the other hand, the customer may actually experience better service than what they were prepared for, but this situation presents its own challenges and is beyond the scope of this paper. Gap 5 also results when any of the other four Gaps open. However, Gap 5 may also open by itself. Note that satisfactory performance results from the interaction of factors that the managers can control (the interior layout of the aircraft, employees) and those that they cannot (other customers, the passenger's emotional state). Thus, a customer flying on a crowded, noisy airplane may be unhappy with the experience even if the service is fine. Similarly, a person who is unhappy, irritated, or simply having a bad day, may be disposed to find fault with very minor company mistakes.

External forces (i.e. laws, governmental regulations, weather, etc.) can also have an impact on the level of service provided by an airline. For example, winter weather can disrupt flight operations and strand passengers, sometimes for days. Also, new government regulations now penalize airlines for ramp/tarmac delays once passengers have boarded. As a result airlines have erred on the side of cancelling flights whenever winter weather threatens which has exacerbated service failures.

In addition, air traffic control requirements can adversely impact airline performance as well. Naturally, situations such as these can have a detrimental impact on customer service even though the company has no control over the factors causing them. The challenge for managers is to minimize the size and occurrence of service quality gaps by understanding the needs of customers, providing a service mix that meets those needs better than the competition,

and constantly monitoring customer satisfaction so that corrective action can be taken immediately if required.

RECONCILING THE NEW AIRLINE MANAGEMENT PARADIGM WITH CUSTOMER SATISFACTION

Based on the financial information presented earlier, U.S. airlines are doing better than they have in years. Flight reductions have led to higher load-factors, fares are rising, and ancillary fees are proving to be especially lucrative. As a result, profits are up. However, none of these factors are particularly appealing from the passenger's point of view implying less schedule choice, more crowded airplanes, and higher costs. In fact, complaints filed by customers with the U.S. Department of Transportation against U.S. Carriers are up almost 8% for the first five months of 2012 versus the same period in 2011 (Airconsumer.gov., 2012). When viewed in the context of the Service Quality Model, this rising level of customer dissatisfaction represents a widening of Gap 5, as a result of Gap 2: i.e. managers know their actions are unpopular with customers, but business realities require that these steps be taken anyway. What, if anything, should management do to mitigate Gap 5 and improve overall customer satisfaction? There are several options.

Do Nothing

Perhaps no management action needs to be taken. Load factors are up, operating costs are down, and profitability is increasing for the first time in years. As a result, management may see a modest increase in the number of customer complaints as a small price to pay for continuing a business model that is both sustainable and profitable. A study by Steven, Dong and Dresner found that market concentration moderates the relationship between satisfaction and profitability for the US airlines. Carriers that operate in concentrated markets have fewer incentives to satisfy their customers than those

that serve more competitive markets (Steven, Dong and Dresner, 2012). The latest round of industry consolidation means customer alternatives are reduced to a smaller number of airlines all following similar strategies, so there is little incentive for passengers to switch carriers. The end result of these changes is that market power has shifted from customers back to managers, with all that change implies.

Realign Carrier Customer Service to Fit Today's Environment

There are some steps management could take to enhance the overall customer experience. First, the collection of fees must be streamlined to eliminate the passenger perception that they are being nicked-and-dimed to death. The reality is that customers find some fees reasonable (priority boarding, preferred seating, upgrades and WiFi) while viewing others (checked baggage) as just the opposite (McCartney, 2012c). Airlines should consider re-bundling some charges into a passenger service fee that everyone pays, similar to what hotels have instituted in the form of a resort fee to cover telephone, internet, fitness center, etc. For an airline, such a fee could cover one checked bag, entertainment, snacks, perhaps internet, but every passenger would pay the fee. There would probably be initial customer dissatisfaction, but the managers could mitigate this resistance by offering enough bundled value that passengers felt like they were getting something even without checking a bag. Furthermore, the presence of a relatively fixed fee would eliminate uncertainty and the feeling of constantly being asked to pay for something. Resort fees that are transparent and fully disclosed prior to check-in have been accepted by customers as preferable to multiple charges for individual items. The airlines could find the same thing happens with a passenger service fee.

Second, baggage simply must be managed better. The implementation of fees for checked luggage forced more bags into the cabin, slowing both

the security screening and aircraft loading processes. If everyone paid the passenger service fee as discussed earlier, perhaps the amount and size of carry-on items would decrease. While the company might experience an increase in the quantity of checked bags, they, along with most airports, already have the infrastructure in place to absorb them. In addition, size and weight limits for cabin bags need to be enforced prior to boarding and preferably before security.

Third, fare transparency should be improved. Vague explanations regarding surcharges, taxes and fees need to be eliminated in favor of full disclosure regarding the true cost of a ticket. Spirit Airlines was sued in August 2012 for collecting a passenger usage fee ranging from \$9 to \$17 per flight segment that appeared to be an officially imposed charge but was, according to the lawsuit, a scheme to collect more money from passengers while advertising a low base fare (Martin, 2012b). Surcharges are especially worrisome because they are intended to be temporary and typically are applied by the carrier. In theory, these should decline or disappear altogether once they are no longer needed to deal with a specific situation. In the absence of clarity, the risk to the customer is that these charges become permanent.

Finally, a system should be developed to allow for the immediate on-board reporting of passenger-related aircraft problems. As flights are reduced and older aircraft are retired, those that remain are flying more. For example, an aircraft might depart from Atlanta for a flight to Amsterdam where it stays for a few hours before flying on to New Delhi. After turning around there, it returns to Amsterdam before continuing back to Atlanta where it is turned back around to make the same circuit again. A passenger confronted with a reading light that does not work, a seat that does not recline, or worst of all, a defective entertainment system, is likely to be stuck with that situation for the duration of their flight because higher load factors mean less opportunity to change seats. The passenger

might advise a flight attendant of the deficiency, but, realistically speaking, there is really nothing they can do other than document the issue in the hope that it will be taken care of at some point. Given the short turn-around times and the lack of comprehensive maintenance support available at en-route stops, the likelihood is that multiple passengers will be dissatisfied as a result of what should be a relatively minor problem. If the aircraft is turned as quickly at its domestic domicile (where maintenance activities are presumably concentrated), the problem may remain unresolved for a lengthy period of time, resulting in a number of dissatisfied customers. Given the prevalence and sophistication of inflight entertainment systems, passengers should be able to register seat-specific complaints that can be (a) viewed immediately by flight service personnel in case there is something they can do to remedy the problem, and (b) sent via aircraft systems directly to maintenance personnel on the ground if in-flight correction is impossible.

A Balanced Approach

Earlier research (Gourdin and Kloppenborg, 1991) found that, up until deregulation, passengers and managers tended to agree on what constituted quality airline service. As a result, customers were satisfied and the airlines were profitable. After 1978, customers became very price sensitive, demanding the high service levels they were used to together with extremely low fares. Managers focused on cutting costs in order to compete in a free-market environment, which meant paring down services. This polarization at opposite ends of the quality spectrum generated passenger dissatisfaction that persisted for 30 years. But the recent events discussed in this paper have forced passengers to redefine their expectations to fit the new reality, presenting airline managers with an opportunity they must not squander by doing nothing. The suggestions made in the above section would go a long way towards improving the customer experience at relatively little cost to the company.

CONCLUSIONS AND FURTHER RESEARCH

The U.S. airline industry has experienced more structural changes in the last five years than at any time since deregulation occurred in 1978. Because passenger expectations for air service quality remained locked in the halcyon days of the 1950s and 1960s, managers were unable to reconcile customer demand for high levels of service and low fares with the economic realities of competing in a free market. As illustrated with the Service Quality Model, customer dissatisfaction was the result as were decades of money-losing airline operations. Recent industry consolidation has reduced the number of competitors and forced passengers to modify their service expectations, which has been good news for managers. As the latter move to improve their respective bottom lines, they need to ensure that they don't alienate their customers. This paper offers executives several options for improving customer satisfaction while continuing to enhance profitability, a seemingly unattainable goal before now. Additional investigation into customer price sensitivity would be invaluable in determining, for example, what amount makes sense for a passenger service fee and to identify new service offerings that people will pay for. One successful innovation is the enhanced economy seating options now being offered by some carriers to those who are willing to pay extra for a bit more legroom and seat comfort on long flights. Perhaps similar revenue opportunities exist in offering improved dining options to coach passengers as well. Additional research into buyer behavior would also be useful in helping managers understand what they can charge for and what they cannot, knowledge especially useful for a carrier with extensive overseas routes.

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U.S. MOTOR CARRIER HOURS OF SERVICE REGULATIONS: THEIR IMPACT ON CARRIER PROFITABILITY AND PRODUCTIVITY

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ABSTRACT

This paper discusses the history of hours of service regulations for U.S. motor carriers and investigates the changes to individual carrier profitability and productivity from the last major change to those regulations in 2003. The results of the analysis indicate that operating ratio worsened and sales per employee improved, and return on assets and return on equity were unchanged due to hours of service changes. The implications of these results given the recent changes to hours of service regulations in 2011 are also discussed.

INTRODUCTION

With the major change to the Federal Motor Carrier Administration (FMCSA) Hours of Service regulations announced in December 2011(HOS, 2011), there has been increased interest in how this will impact motor carriers. Prior to the publication of the final rule, several studies regarding highway safety and the health of truck drivers were published (Hall and Mukherjee, 2008; Jovanis et al., 2005; Min, 2009; Saltzman and Belzer, 2002), but little or no research has been conducted on the impact of HOS on the profitability and productivity of individual firms. The Regulatory Impact Analysis (FMCSA, 2010) includes an estimate of the cost of reduced productivity at the macro level but not at the firm level. The estimates used to calculate reduced productivity were also called into question in a paper prepared for the American Trucking Association by Edgeworth Economics (2011). Due to the questions about research on the impact of HOS on costs and productivity at the macro level, and a lack of research at the firm level; this paper will investigate the impact of changes to HOS at the

firm level, which may also add some insight into the macro-economic impact of these changes.

The last major change to HOS occurred in 2003 and went into effect in January of 2004. The 2003 HOS reduced the allowable on-duty time per work/rest cycle¹ by one hour, increased the allowable driving time per work/rest cycle by one hour, and decreased the on-duty and work time per day by two hours. However, with the addition of the 34 hour restart², the maximum on-duty and driving time per week were increased by 14 and 7 hours and the maximum long-term average on-duty and driving hours were increased by approximately 21 and 14 hours. These dramatic changes led to a period of uncertainty concerning the future of HOS with multiple law suits, court actions, and acts of Congress, which resulted in the issuance of the 2011 HOS.

Before the final 2011 HOS were publicized, there was discussion about decreasing the on-duty and driving hours per work/rest cycle by one to two hours, but the final rule retained the 14 hour on duty and 11 hour driving limits per

work/rest cycle from the 2003 HOS. The most significant change to the 2011 HOS is the requirement of a minimum 30 minute break after 8 hours of driving and severely limiting the use of the 34 hour restart. Under the new rule, the 34 hour restart can only be used once per week (168 hours) and must include two time periods between 1:00 am and 5:00 am. The once per week restriction is intended to allow a driver to work one long week but force him to follow that with a short week, and the 1:00 am through 5:00 am restriction is intended to allow night drivers two periods of night rest to recover (FMCSA, 2011). While these changes will not impact the maximum daily or weekly driving or on-duty times, they will restrict the maximum average weekly driving and on-duty times to a point halfway between those allowed under the 1962 HOS and the 2003 HOS. Therefore looking at the impact of the 2003 HOS changes to motor carrier profitability and productivity should give some insight into the impact of the 2011 HOS on motor carriers.

This paper investigates the actual impact of the last major change to the HOS on profitability and productivity of publicly traded motor carriers. Quarterly data from 1997-2010 for 14 publicly traded motor carriers was used. To see the impact on profitability, Operating Ratio (OR) and Return on Assets (ROA) were dependent variables in two separate models. The variable of interest was a dummy variable with a value of zero for the time periods before the change to HOS (1997-2003) and a value of one for the time periods after the change (2004-2010). Various control variables were also included to account for economic and regulatory changes that took place in the sample period. To see the impact on productivity, a similar model was tested with sales per employee as the dependent variable. Results of the estimations indicate that

the 2004 HOS led to better productivity, a worse OR, and no significant change to ROA. These results would suggest that the 2011 HOS will potentially negatively impact productivity and positively impact profitability.

HISTORY OF HOURS OF SERVICE RULES

HOS were first proposed by the ICC in 1936 and went into effect in July of 1938. These rules allowed for 15 hours on-duty and 12 hours of work per day, which could all be driving or could also include other tasks such as loading, unloading, and completing paperwork. Drivers were also required to have at least 9 hours off duty each day. A limit of 60 hours on-duty in 7 days or 70 hours on-duty in 8 days was also instated. These rules resulted in protests from both organized labor and some motor carriers, so in early 1939 revised rules went into effect. These new rules reduced the required off duty time to 8 hours per day and implemented a 10 hour driving limit per day instead of the previous 12 hours of work per day. The next change came in 1962 when, for unexplained reasons, the ICC changed the rule to allow for a maximum driving time of 10 hours and on duty time of 15 hours, which could be extended to 16 hours with breaks, after 8 hours off duty, so maximum on duty and driving time per day became maximums per work/rest cycle. This change allowed drivers up to 16 hours of driving and on-duty time per day (FMCSA, 2000). The 1962 hours of service regulations increased the maximum driving time per day, but the retention of the weekly limits kept maximum and average weekly driving times the same. A driver could simply reach his 8 day on-duty limit in 5 days rather than 7 days, allowing for greater flexibility in scheduling.

The HOS remained virtually unchanged until 2003. With the ICC Termination Act of 1995, jurisdiction for HOS was given to the Federal Highway Administration (FHWA). The FHWA

was asked by Congress to re-examine HOS with a focus on public safety and driver health. An advanced notice of proposed rulemaking was issued in 1996, but no further action was taken. In 2000 jurisdiction was transferred to the Federal Motor Carrier Safety Administration (FMCSA) and a notice of proposed rulemaking was issued. In 2003 the FMCSA issued a final rule, which went into effect in January 2004. The 2003 HOS decreased maximum on-duty time to 14 hours (including any breaks), increased maximum driving time to 11 hours per work/rest cycle, and increased off duty time to 10 hours. Furthermore, the 34 hour restart was added, which allows a driver to reset the 7 or 8 day time limit effectively adding up to 14 hours to a driver's work week (Jones, 2007). The 2003 HOS led to a period of unrest and uncertainty about the future of hours of service regulations in the U.S.

The first lawsuit following the 2003 HOS was filed by the consumer advocacy group, Public Citizen, before the rule even went into effect, and the U.S. Court of Appeals for the D.C. Circuit struck down the rule in 2004 citing the fact that the FMCSA failed to take into account driver health, as required by law, when setting the 2003 HOS. Following that court ruling, Congress granted temporary relief from the ruling, and President Bush signed the Surface Transportation Extension Act of 2004, giving FMCSA a year to come up with a rule addressing the court's issues with the 11 hour driving limit and 34 hour restart. In January 2005 FMCSA issued a notice of proposed rules that make few changes to the 2003 HOS other than changes to the split sleeper berth provisions. This was subsequently published as a final rule in August 2005 and went into effect in October 2005. In 2006 Public Citizen once more filed suit in federal court arguing for different changes in the HOS, which resulted in

a federal appeals court vacating two provisions of the rule in July 2007. At the request of the American Trucking Association, the court issued a 90 day stay to its mandate in September 2007. The FMCSA then issued an interim final rule in December 2007 identical to the 2005 rule, and this was subsequently issued as a final rule in November 2008. Public Citizen once more filed suit in March 2009, and a settlement was reached before the suit went to court. Therefore, despite multiple lawsuits resulting in the 2003 HOS being struck down, the 2003 HOS have remained virtually unchanged. The only change came in 2005 and mandated that 8 of the 10 hours off duty for drivers operating with a sleeper berth be taken consecutively (Jones, 2007; Munroe, 2009; Public Citizen, 2012).

As part of a settlement between FMCSA, the Teamsters Union, Public Citizen and several safety groups, FMCSA agreed to revise the HOS taking into account drivers' health and safety. The proposed 2011 HOS were released in December 2010, and the final rule was released in December 2011. The compliance date for the on-duty time and egregious violation definitions and oil field exemption³ was February 27, 2012, and all other provisions had a compliance date of July 1, 2013. These new rules maintain a maximum 11 hours of driving time but require a 30 minute break after 8 hours of driving. The maximum on-duty time remains at 14 hours but is effectively reduced to 13.5 with the required break, unless the break is incorporated with the split sleeper berth provision. Limitations to the 34 hour restart will require that it include two periods between 1:00 am and 5:00 am and can only be used once every 7 days or 168 hours. Finally, the definition of on-duty time has been modified to not include any time resting in a parked vehicle (this could include detention

time) or up to two hours in a passenger seat of a moving vehicle following 8 hours in the sleeper berth (FMCSA, 2011). Following the publication of the final 2011 HOS, the American Trucking Association filed a petition with a federal court asking the court to review the 2011 HOS in February 2012 and filed an issue statement in March 2012. The primary issues identified are with the limitation to the 34 hour restart and the inclusion of a mandatory 30 minute break following 8 hours on-duty (McNally, 2012a; McNally, 2012b).

To help clarify the differences between the different HOS that have been in place over the last 74 years, Table 1 summarizes the HOS from 1938 – 2011. This table identifies the maximum driving and on duty time per sleep/work cycle and the potential maximum driving and on-duty time per 24 hour period. In addition the maximum driving and on-duty time possible in a single week as well as the potential maximum average driving and on-duty time is included in Table 1. These figures are based on a driver either driving the maximum allowable time, taking the minimum off duty time, and resuming driving or being on-duty the maximum allowable time, taking the minimum off duty time, and resuming driving. As shown in Table 1, the 2003 HOS reduced both the potential drive time and on-duty time per day but significantly increased the potential drive time or on-duty time per week with the introduction of the 34-hour restart, and the 2011 HOS reduced these weekly times to a point approximately midway between those allowed under the 1962 HOS and the 2003 HOS with the new limitations on the 34-hour restart. McCartt et al. (2008) report that approximately 80 per cent of drivers were using the restart provision as part of their regular schedule in 2004 and 2005, so the new

limitations to this provision could have significant impact throughout the trucking industry.

ECONOMETRIC MODEL

For this study, three separate models were developed to address the impact of the 2003 HOS on motor carrier profitability as measured by operating ratio (OR), return on assets (ROA), and return on equity (ROE). A fourth model was developed to look at the impact on productivity as measured by sales per employee (SPE). All four models used the same independent variables. The variable of interest, PHOS, is a dummy variable indicating whether an observation was taken after the 2003 HOS, which went into effect in January of 2004. The impact of this regulation is difficult to predict in advance because, depending on the practices of a particular firm, the maximum driving time per day would have either been increased by 1 hour (maximum time per duty cycle) or decreased by 2 hours (maximum time per day) and on-duty time was decreased by 1 hour (maximum time per duty cycle) or 2 hours (maximum time per day). In addition to the HOS that went into effect in 2004, two other types of regulations, Ultra Low Sulfur Diesel (ULSD) requirements and stricter emissions standards, likely had impacts on motor carrier revenues and profitability and went into effect between 2004 and 2010.

ULSD was phased in between 2006 and 2010 with all 2007 and newer vehicles required to only run on ULSD. This change had an impact on the price of diesel and on the price of tractors which had to be modified in order to run with the lower lubricity of ULSD. To incorporate additional operating cost from this change into

**TABLE 1:
SUMMARY OF HOS RULES**

HOS	Drive Time per Cycle	Drive Time per Day	On-Duty Window per Cycle	On-Duty Time per Day	Off-Duty Time per Cycle	Max. Wkly. Drive Time	Max. Avg. Wkly. Drive Time	Max. Wkly. On-Duty Time	Max. Avg. Wkly. On-Duty Time	7(8) Day Limit	34-hour Restart
1938	12	12	12	12	9	70	61.25	70	61.25	60 (70)	No
1939	10	10	16	16	8	70	61.25	70	61.25	60 (70)	No
1962 ¹	10	16	15	16	8	70	61.25	70	61.25	60 (70)	No
2003 ²	11	14	14	14	10	77	73.92	84	81.67	60 (70)	Yes
2011 ³	11	14	14	14	10	77	66	84	70	60 (70)	Limited

¹ Before the addition of the 34 hour restart the maximum time a driver could work was 60 hours in 7 days or 70 hours in 8 days (for a carrier operating 7 days per week). However, it was allowable to accumulate all 70 hours within 7 days or less and take time off duty for the remainder of the 8 days. However, the maximum average work hours per week was restricted by the 8 day driving limit to 61.25.² With the addition of the 34 hour restart in 2003, it would be allowable for a driver to accumulate 66 hours of driving time in 5 days, take a 34 hour break, and accumulate an additional 11 hours of driving time before week's end for a total of 77 hours in 7 days (assuming no other on-duty time). Furthermore, the maximum average long run average driving hours per week was 73.92 hours. A driver with 14 hours of on-duty time every cycle could accumulate up to 84 hours of on-duty time in a single week (66 hours of driving time) with a maximum average weekly on-duty time of 81.67 hours.³ With the limitations to the 34 hour restart in 2011, a driver would be able to maximize daily drive time by incorporating the mandatory 30 minute break into the 2 hour portion of their split sleeper berth time. In a single day a driver could drive 8 hours, take two hours off duty, drive 3 hours, take 8 hours off duty in the sleeper berth, and drive an additional 3 hours (a driver not using the split sleeper berth provision could drive a maximum of 13.5 hours in a single day). Continuing the pattern of drive 8, rest 2, drive 3, rest 8 through 66 hours of driving time, using the 34 hour reset and continuing the pattern again would allow for a maximum of 77 hours of driving time in a single week, but would be required to take additional time off the following week for an average of 66 hours of driving time per week. A driver using 14 hours of on-duty time every cycle and a similar strategy could work a maximum of 84 hours in a single week but would be limited to 56 hours the following week for an average of 70 hours on-duty time per week. These maximum weekly and average weekly driving and on-duty times would be the same for a driver not using the split sleeper berth provision and would generally include a longer week followed by a shorter week.

the model, the percentage change in average diesel price from the previous quarter or change in diesel price (CDP) was used as an independent variable. The average diesel price may not be the same for all carriers, but the percent increase or decrease should be similar for all carriers operating in all different parts of the country. Additionally the average diesel price exhibited a high level of autocorrelation.

Stricter emissions standards were implemented for 2004 and newer vehicles, and then even stricter emissions standards were implemented

for 2007 and newer vehicles and phased in through 2010. Due to the language of the law, there were modest increases in new vehicle prices in 2004 and 2007 followed by large increases in 2010. To incorporate this information into the model, the average percent change in new tractor price (CTP) was included as an independent variable. While it would be preferable to obtain the actual price per tractor from each carrier, that information was unavailable, however, tractors are sold in a competitive environment, so the average price increase or decrease should be correlated with

each individual carrier's cost of equipment. As with average diesel price, average tractor price exhibited a high level of autocorrelation, so percentage change was used in the model.

To control for general economic conditions, the percentage change in Gross Domestic Product (GDPD) for the services sector was included in the model as well as a dummy variable for any quarter that had a month classified as recession (REC). To control for the different business environments less-than-truckload (LTL) and truckload carriers operate in and the different business environments between unionized and non-unionized carriers, dummy variables were

included for LTL and unionized carriers (UC). Finally, dummy variables were included for the four quarters of the year. Manufacturing shipments were considered as an independent variable, but that measure was highly correlated with the quarter of the year (Q_1 - Q_4), and a better fit to the data was obtained by using the quarterly dummy variables. Firm specific dummy variables were not included in the models as indicated by a Hausman Test for random effects.

Putting these variables together resulted in the following four equations to be estimated:

$$OR = \beta_1 PHOS + \beta_2 CTP + \beta_3 CDP + \beta_4 CGDP + \beta_5 REC + \beta_6 LTL + \beta_7 UC + \sum_i \beta_{Qi} Q_i + \varepsilon \quad (1)$$

$$ROA = \beta_1 PHOS + \beta_2 CTP + \beta_3 CDP + \beta_4 CGDP + \beta_5 REC + \beta_6 LTL + \beta_7 UC + \sum_i \beta_{Qi} Q_i + \varepsilon \quad (2)$$

$$ROE = \beta_1 PHOS + \beta_2 CTP + \beta_3 CDP + \beta_4 CGDP + \beta_5 REC + \beta_6 LTL + \beta_7 UC + \sum_i \beta_{Qi} Q_i + \varepsilon \quad (3)$$

$$SPE = \beta_1 PHOS + \beta_2 CTP + \beta_3 CDP + \beta_4 CGDP + \beta_5 REC + \beta_6 LTL + \beta_7 UC + \sum_i \beta_{Qi} Q_i + \varepsilon \quad (4)$$

MODEL DATA

For this analysis, quarterly data for 14 out of 17 publicly traded motor carriers with data available from 1997-2010 was used, resulting in 56 observations per carrier and a total of 784 observations. The years 1997-2010 were chosen, so there would be an even number of observations on each side of the 2003 HOS. Landstar was excluded because it is a non-asset based carrier, and therefore, operates in a somewhat different business environment. UPS Freight and FedEx Freight were also excluded because their SEC filings don't separate out the LTL portion of their business from the express,

small package, and other portions of their business. Furthermore, YRC Worldwide was excluded from the estimation of Equation 3 due to the company's negative equity in Q2-Q3 2009 and Q1-Q4 2010. Table 2 lists the 14 carriers included in the sample as well as whether they were LTL carriers or unionized (UC). For purposes of the analysis, any carrier with a significant portion of their business coming from LTL business was considered LTL because they would have made the significant capital investment in terminals required of LTL carriers.

**TABLE 2:
CARRIERS INCLUDED IN SAMPLE**

Company Name	LTl	Union
Arkansas Best Corporation	Y	Y
Celadon Group, Inc.	N	N
Con-way, Inc.	Y	N
Covenant Transportation Group, Inc.	N	N
Frozen Food Express Industries, Inc.	Y	N
Heartland Express, Inc.	N	N
J B Hunt, LLC.	N	N
Knight Transportation, Inc.	N	N
Marten Transport, LTD.	N	N
Old Dominion Freight Line, Inc.	Y	N
PAM Transportation Systems, Inc.	N	N
USA Truck, Inc.	N	N
Werner Enterprises, Inc.	N	N
YRC Worldwide, Inc.*	Y	Y
*Not included in Equation 3 due to negative equity in 6 quarters of the sample period.		

The financial data for the carriers (total sales, cost of goods sold, total assets, total equity, and number of employees) came from Standard and Poor's Compustat North America. From this data, operating ratio (OR), return on assets (ROA), return on equity (ROE), and sales per employee per quarter in thousands of dollars (SPE) were calculated. The average tractor price was obtained from Paccar Truck's SEC filings, in which they list the revenue from truck sales and units sold. The average tractor price was calculated from this and then adjusted for inflation using the Producer Price Index (PPI) for heavy trucks obtained from the Bureau of Labor Statistics (BLS) (2012). Average diesel price was obtained from the U.S. Energy Information Administration (EIA) (2012), and it was also adjusted for inflation using the PPI, and the CDP was then calculated. GDPD was obtained from the Bureau of Economic Analysis (BEA) (2012). Data on recessions was obtained from the National Bureau of Economic Research

(NBER) (2012). Table 3 lists the variables used in the analysis as well as some descriptive statistics. Dummy variables are included to show what percentage of time or carriers fall into which categories.

ANALYSIS AND RESULTS

The final four models were estimated using SHAZAM econometric software with the POOL command. This is a generalized least squares (GLS) estimator that assumes and corrects for heteroskedasticity and autocorrelation within cross sections, different values of rho for each cross section, and correlation between error terms from different cross sections. Initial testing performed by SHAZAM (Whistler et al., 20011) indicated that these assumptions were justified.

The results of the analysis are summarized in Table 4. The first R² reported in Table 4 is based

**TABLE 3:
DESCRIPTIVE STATISTICS OF VARIABLES**

Variable	Mean	Std. Dev.	Min	Max
OR	86.31	7.31	65.24	119.44
ROA	4.44	7.80	-69.32	18.24
ROE	9.64	16.15	-134.77	63.31
SPE	29.89	7.21	11.82	56.50
CTP	0.13	2.85	-7.30	12.44
CDP	1.43	9.48	-32.24	24.00
CGDP	2.34	1.77	-2.30	6.20
PHOS	0.50	0.50	0.00	1.00
LTL	0.36	0.48	0.00	1.00
UC	0.14	0.35	0.00	1.00
REC	0.20	0.40	0.00	1.00
Sources:	National Bureau of Economic Research, 2012 Paccar, Inc., 1997-2012 Standard and Poor's Compustat North America, 2011 U.S. Bureau of Economic Analysis, 2012 U.S. Bureau of Labor Statistics, 2012 U.S. Energy Information Administration, 2012			

on the residuals from the Best Linear Unbiased Predictor (BLUP), which uses the coefficients on the untransformed variables to predict but then adjusts that prediction using the residual from the previous period multiplied by rho for the particular firm in question. The second R^2 reported is based on a method described by Buse (1973) as an appropriate R^2 to use for GLS estimation. These goodness of fit measures show that Equations 1 and 3 were most effective for prediction and Equation 2 explained little of the variance in return on equity.

The most interesting result of Equation 1 was that the operating ratio for the firms in question actually worsened after the 2003 HOS, indicating that despite the fact that drivers could accumulate more driving or on-duty hours in a day or week, many of the carriers were not able to decrease their expenses relative to revenue. This appears to be the case even after accounting for tractor and diesel prices, economic growth, and recessions. The other results of Equation 1

were much as expected: an increase in equipment or fuel prices leads to a worse OR, an increase in GDP leads to a better OR, a recession leads to a worse OR, and LTL carriers and unionized carriers experience higher costs than TL or non-unionized carriers.

The estimated coefficients of Equation 2 and Equation 3 reveal that the 2003 HOS changes, tractor prices, and diesel prices have no significant impact on ROA or ROE; however, the signs of the estimated coefficients are negative, consistent with the results of Equation 1. It seems that any increased expenses or decreased revenue contributing to the higher OR are able to be accounted for by reducing assets and equity or exploiting some source of profit other than from operations. Furthermore, Equation 2 shows that LTL carriers may be able to actually achieve a slightly higher ROA than TL carriers (the sign is positive but only significant at the 0.10 level), and unionized carriers tend to have a lower ROA than non-

TABLE 4:
RESULTS OF ESTIMATION

Independent Variable	Estimated Coefficient (p-value)			
	Equation1 (OR)	Equation 2 (ROA)	Equation 3 (ROE)	Equation 4 (SPE)
PHOS	0.807	-0.806	-1.783	2.770
	(0.03)	(0.25)	(0.14)	(0.00)
CTP	0.043	-0.024	-0.038	0.046
	(0.03)	(0.63)	(0.72)	(0.14)
CDP	0.024	-0.004	0.025	0.059
	(0.00)	(0.81)	(0.48)	(0.00)
CGDP	-0.208	0.418	0.789	-0.024
	(0.01)	(0.02)	(0.02)	(0.84)
REC	0.807	-1.682	-2.832	0.724
	(0.00)	(0.01)	(0.03)	(0.09)
LTL	2.828	1.320	-0.450	4.106
	(0.01)	(0.09)	(0.83)	(0.01)
UC	7.153	-3.403	1.353	4.849
	(0.00)	(0.02)	(0.69)	(0.00)
Q1	85.149	2.972	5.094	25.198
	(0.00)	(0.00)	(0.00)	(0.00)
Q2	83.562	5.236	9.447	26.896
	(0.00)	(0.00)	(0.00)	(0.00)
Q3	83.635	4.416	8.911	27.501
	(0.00)	(0.00)	(0.00)	(0.00)
Q4	83.938	3.797	7.172	27.334
	(0.00)	(0.00)	(0.00)	(0.00)
R ² _{BLUP}	0.896	0.417	0.314	0.863
R ² _{BUSE}	0.312	0.113	0.108	0.228

unionized carriers. Equation 3, on the other hand, shows no significant difference in ROE between LTL and TL carriers or between unionized and non-unionized carriers, but this result is likely due to the fact that the largest LTL and unionized carrier was excluded from the sample. Other hypotheses confirmed by Equation 2 and Equation 3 are that a growing economy allows for higher ROA and ROE and a recession is associated with a lower ROA and ROE.

Rather than financial performance, Equation 4 deals with productivity, and the results are much as expected because longer driving times per day and week should lead to the same work being accomplished with fewer employees. Sales per employee increased after the 2003 HOS regulatory change. Tractor price increases have no significant impact on SPE. Diesel price increases have a slight impact on SPE likely due to the increase in revenues from higher fuel surcharges. GDP changes seem to have no impact on productivity, but it may be slightly higher during a recession (significant at the 0.10 level). Finally, LTL and unionized carriers tend to have higher sales per employee, most likely because of the higher prices charged to customers. These higher prices are apparently not enough to cover the additional expenses from higher capital expenses for LTL carriers and higher wages for unionized carriers because Equation 1 reveals a higher OR for LTL than for TL carriers and a higher OR for unionized carriers than for non-unionized carriers.

CONCLUSIONS

The results of this study indicate that despite motor carriers being able to increase their sales per employee after the 2003 HOS, they were

unable to improve or even maintain their operating ratios. However, they were able to maintain, but not increase, profitability as measured by ROA and ROE, possibly due to a reduced need for capital investments in tractors and terminals resulting from this increased productivity. Whatever the reason for this lack of impact to ROA and ROE, it shows that publicly traded motor carriers are flexible enough to maintain these measures of profitability despite changes to federal regulations.

The applicability of these results to the impact on carriers from the 2011 HOS is somewhat unclear, but one would expect to see somewhat of a reversal due to the newly added restrictions to the 34-hour restart provision. This is based on a survey by McCartt et al. (2008), in which drivers were interviewed at weigh stations in Pennsylvania and Oregon in 2004 and again in 2005. The results of the survey indicate that approximately 80 per cent of drivers drove fewer or about the same hours per day in 2004 and 2005 as before the 2003 HOS went into effect, but approximately 80 per cent of drivers use the restart provision as part of their regular schedules. This indicates that driving hours per day were minimally impacted by the changes, but driving hours per week likely increased (necessitating the use of the restart provision). If this is the case, the restriction of the restart provision implemented in the 2011 HOS will likely decrease the hours driven per week. Therefore, assuming the same patterns hold, the implementation of the 2011 HOS in 2013 will likely result in both an improved OR and decreased SPE for motor carriers, and one would expect to see minimal impact to ROA and ROE.

The results of this study indicate that motor carriers should not be overly concerned about a loss of profitability resulting from any forthcoming reductions in maximum driving hours per day. While this will not happen in the immediate future, it could still be an issue despite the final 2011 HOS including no reduction to maximum driving time. The final rule states that if new research comes out showing improved health of drivers or safety of the general public from a reduction in maximum driving time, the rule could be modified (FMCSA, 2011). If this does occur, carriers could expect to see minimal changes to productivity and operating ratio and should be able to maintain their ROA and ROE if the same pattern is followed. The results also indicate that carriers could expect to see minimal changes to ROA or ROE from the 2011 HOS as written and a decrease to both operating ratio and sales per employee. However, it remains to be decided in court whether the 2011 HOS will stand as written or be revised yet again.

LIMITATIONS AND FUTURE RESEARCH

The most obvious limitation of this research lies in the sample size and selection. Rather than taking a representative sample of carriers, a convenience sample of publicly traded carriers were used. In the case of the motor carrier industry the publicly traded carriers are also some of the largest, but they are also a rather small group. This limitation leads to the most obvious extension for future research: to conduct the same analysis using a larger, more representative sample. Of course, future research based on a larger sample would need to be based on case study or survey data due to the fact that financial statements are not publicly available for most motor carriers.

Further limitations of the study were the use of industry averages for the price of equipment and the price of fuel due to a lack of availability of firm specific values for these measures. Using case study or survey data for future research on this matter should alleviate this problem. Finally this study used sales per employee as a measure of productivity rather than sales per driver or sales per driver hour. While these measures may be highly correlated for many carriers, there is no way to know for sure without both variables. So the most significant limitations of this research lie in sample size and selection and variables used. All of these issues stem from data availability and could be alleviated by conducting further research using case study and/or survey data to get more specific variables and a larger, more representative sample.

ENDNOTES

¹One work/rest cycle would include the time from when a driver comes on duty until he is able to come on duty again. For a driver, driving as many hours as possible under the 2003 HOS, this is between 21 and 24 hours with up to 11 hours of driving, up to 14 hours on duty, and at least 10 hours of sleep.

²A driver working every day is allowed a maximum of 70 hours on duty time in 8 days (192 hours), but taking 34 hours off duty allows a driver to reset the clock as if he had not worked at all in the last 192 hours.

³The definition of “on duty time” was adjusted to not include time spent resting in a parked vehicle after being released from duty, “egregious” HOS violations were specifically defined as driving 3 or more hours beyond the driving time limit and subject to maximum civil penalties, and logging requirements for certain drivers at oil fields were clarified.

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A DECISION SUPPORT SYSTEM FOR DEVELOPING THE MANAGERIAL POLICY OF URBAN PARATRANSIT SERVICES: A CASE STUDY OF THE MASSACHUSETTS BAY TRANSIT AUTHORITY

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ABSTRACT

In the wake of the Americans with Disability Act (ADA) of 1990, paratransit services were offered to improve mobility, employment opportunities, and access to community services for individuals who are mentally or physically handicapped. Due to the complexity involved in ADA rules and transportation regulations as well as the customized, on-demand service requirements, paratransit services are far more costly to render than fixed-route based mass transit services. In times of ongoing budget crisis among public entities, many public transit authorities cope with a dilemma of meeting the growing demand and complex service requirements, while controlling rising paratransit costs. Considering this dilemma, this paper proposes a decision support system (DSS) that can aid the mass transit authority in evaluating paratransit service performance, while continually improving performance over time. To validate the usefulness of the proposed DSS, it has been applied to the actual case of the Massachusetts Bay Transit Authority (MBTA).

INTRODUCTION

Paratransit is the transportation service that supplements larger public transportation systems by providing individualized rides without fixed routes or timetables. In 1990, the Americans with Disabilities Act (ADA) was passed which allowed passengers who cannot use regular public transportation services due to their physical, cognitive, or mental disability to use alternative paratransit services complementary to the fixed route services already in place. Such paratransit was not mandated by law until 1990, but has been provided to individuals in a similar form in the greater Boston metropolitan area since 1977.

The U.S. Department of Transportation (USDOT) regulations, which implement the transportation provisions of the ADA, require

that public transit agencies which provide fixed route service also provide “complementary paratransit service” to persons with disabilities who are unable to use the fixed route system. The level of service provided by the paratransit program must be “comparable” to that provided by the fixed route service. Such comparability is determined by six service criteria: (1) Service area; (2) Response time; (3) Fares; (4) Days and hours of operations; (5) Trip purposes served and; (6) Capacity constraints.

Section 12143 of the ADA rules and regulations state that if an entity operates a fixed route system (other than a system which provides solely commuter bus service) but fails to provide paratransit and other special transportation services to these individuals, it is considered to be discriminatory against individuals with disabilities. This includes individuals who use

wheelchairs. These individuals should be allowed to use a level of service (1) which is comparable to the level of designated public transportation services provided to individuals without disabilities using such system; or (2) in the case of response time, which is comparable, to the extent practicable, to the level of designated public transportation services provided to individuals without disabilities using such system. The requirement is that any entity such as the Massachusetts Bay Transit Authority (MBTA) running a fixed route system must provide a comparable service area of ½ mile surrounding each of the fixed rail or bus routes. Fares, days and hours, trip purposes (i.e. going to work, going to medical appointment, going shopping, etc.), and capacity constraints are required to be comparable to that of a fixed route service.

The paratransit service required by the ADA states that prices to its customers must be comparable to that of the public transit already in existence. Since the public transit fare is usually quite low, the state and municipal governments that typically finance the public transit system need to deal with the dilemma of absorbing the mounting cost of paratransit. The rising cost of paratransit is due to many factors. These include vehicle purchases, maintenance and repairs, insurance, fuel, driver wages, administration, overhead and incentive programs for contractors. As demand rises with the increase of elderly persons from the Baby Boomer era, there is a need for more affordable paratransit service. Since the revenue from the riders' fares only covers a small portion of the cost of running paratransit services, there is a growing concern that quality of service will be compromised. For example, fares covered less than 4% of the MTA New York City Transit's operating expenses (Lowenstein, 2006). The rising costs are directly associated with the increased demand, because more vehicles and drivers are needed to cover the increased demand. Rising fuel costs are also a cause for concern given crude oil prices in the range of \$100 a barrel.

In addition, paratransit regulation often mandates the establishment of specific operating policies with respect to: (1) The level of assistance provided; (2) Employee training; (3) Secure systems; (4) Accommodation of service animals and life support equipment and; (5) No-show policies. Lastly, rules and regulations require that public entities providing complementary paratransit have a process for determining eligibility for ADA Paratransit and who qualifies to use the paratransit service.

There are two types of paratransit services required by ADA: (1) door-to-door service and; (2) curb-to-curb service. Door-to-door service is the service in which the driver will assist the rider from their door to the vehicle at their pickup location and will assist the rider from the vehicle to the door of their destination, while curb-to-curb service is similar to a taxi service where the driver will wait in the vehicle for the rider to embark the vehicle and drop them off at the rider's destination without any assistance. Since door-to-door service takes more time and additional driver's efforts, such services may be curtailed in time of budget crisis.

There are many studies that have been performed to evaluate the efficiency of paratransit systems worldwide. These include peer to peer analyses as well as historical data analyses. Some studies (Lave and Rosemary, 2000; Min, 2011) recognized the increased need for paratransit service as well as improvements that will need to be made in order to meet the demand of paratransit passengers. Other studies such as Fu, Yang and Cosello (2007) and Min and Lambert (2010) evaluated the comparative performance of individual paratransit systems to identify "best practice" (most efficient) agencies and the sources of their efficiency. Thus, upon identifying the most efficient systems along with the influencing factors, new service policies, management and operational strategies may need to be developed for improved resource utilization and better quality of service (Fu, Yang and Cosello, 2007). In a similar manner, there

have been studies on the development of methodologies to estimate confidence intervals of certain analyses of efficiency of individual urban paratransit agencies and the statistical significance of trends in individual agency efficiency (Barnum, Gleason and Brendon, 2007). The studies discussed above were taken into consideration in deciding what analysis would be appropriate for the historical data provided by the MBTA's THE RIDE Paratransit system in the Greater Boston area.

MBTA's THE RIDE

The Massachusetts Bay Transit Authority's (MBTA) THE RIDE is the paratransit system in place in the Greater Boston Metropolitan area in Massachusetts. THE RIDE program is an advanced notice, shared-ride, door-to-door paratransit program for persons with disabilities adhering to the ADA's rules and regulations. This paratransit service has been running since 1970, twenty years before the requirement of such service. This gives THE RIDE a bit of an advantage because of the experience it has in running such a service.

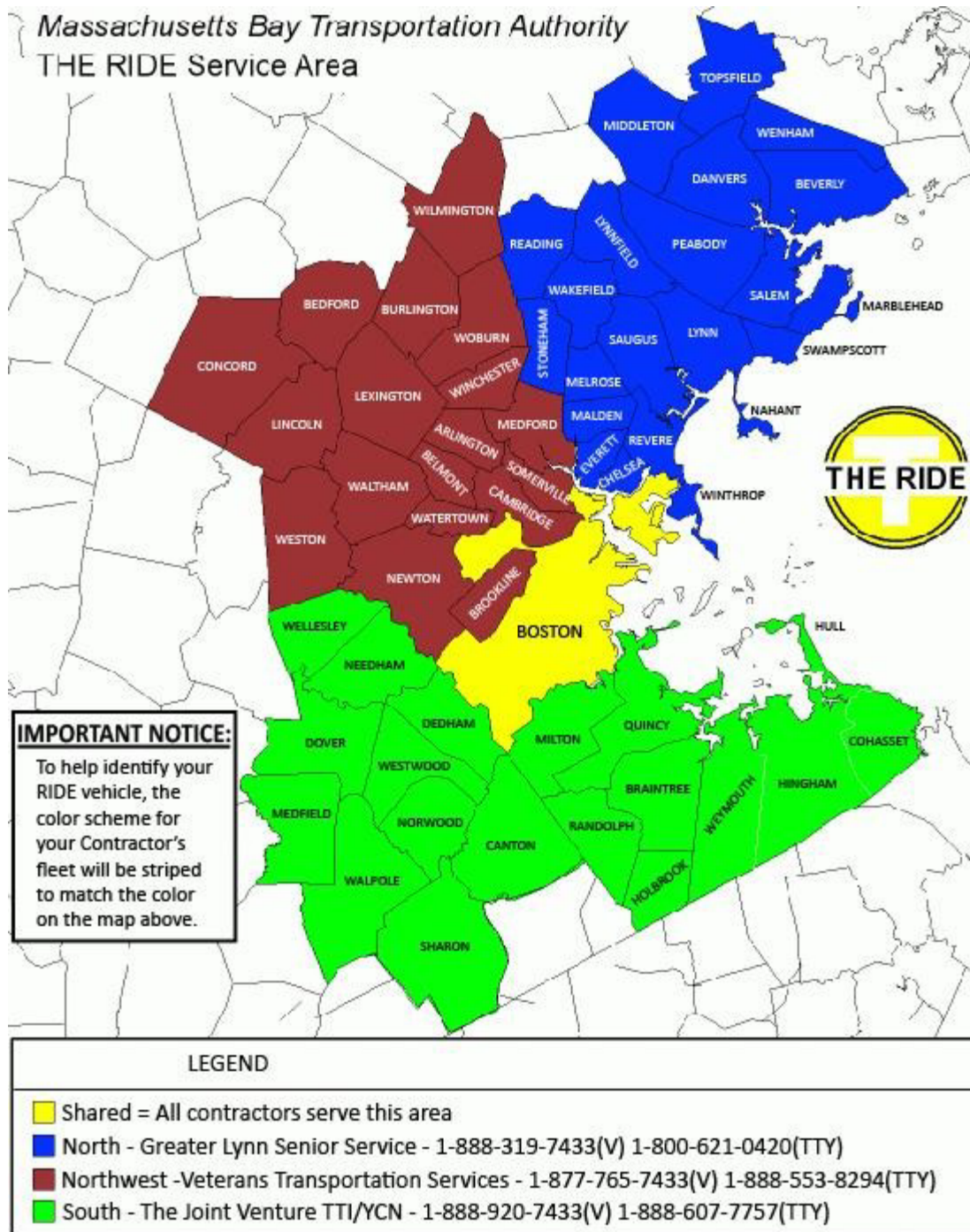
THE RIDE program currently operates under Federal ADA regulations, providing service to over 60 cities and towns covering 688 square miles, 7 days a week, generally from 6 a.m. to 1 a.m., including holidays. THE RIDE costs each passenger \$2.00 per one way trip. THE RIDE program is managed by the MBTA's Office of Transportation Access (OTA) comprised of seventeen (17) staff members. The staff in OTA administers and manages all aspects of THE RIDE program. Their responsibilities include setting service policies and standards, contracting and overseeing contracted service providers, rider eligibility certification, and customer service (handling and investigating rider complaints), and posting fare deposits to customer's RIDE accounts. The Office also purchases and leases many of the 635 lift-equipped vans/sedans used by the three contracted service providers: (1) Greater Lynn

Senior Services; (2) Veterans Transportation Services; and (3) the Joint Venture. THE RIDE uses these three contractors to meet its obligations to provide paratransit service. All contractors were required to bid on the service contract to best exemplify the type of customer service, pricing, and other systems in place to meet and exceed the ADA requirements. The map below depicts the service area for each contractor with different shades of colors. Greater Lynn Senior Services is responsible for the area in blue to the North of Boston, Veterans Transportation Services (VTS) is responsible for the area in red to the Northwest of Boston, and Joint Venture is responsible for the area in green to the south of Boston. All contractors are responsible for Boston, in yellow on the map.

The cities and towns covered by the MBTA's THE RIDE in the four service areas are as follows (see Figure 1). (1) North of Boston: Beverly, Chelsea, Danvers, Everett, Lynn, Lynnfield, Malden, Marblehead, Melrose, Middleton, Nahant, Peabody, Reading, Revere, Salem, Saugus, Stoneham, Swampscott, Topsfield, Wakefield, Wenham, and Winthrop. (2) Northwest of Boston: Arlington, Bedford, Belmont, Brookline, Burlington, Cambridge, Concord, Lexington, Lincoln, Medford, Newton, Somerville, Waltham, Watertown, Weston, Wilmington, Winchester and Woburn. (3) South of Boston: Braintree, Canton, Cohasset, Dedham, Dover, Hingham, Holbrook, Hull, Medfield, Milton, Needham, Norwood, Quincy, Randolph, Sharon, Walpole, Westwood, and Weymouth. (4) Boston which includes Allston, Back Bay, Brighton, Charlestown, Chinatown, Dorchester, Downtown Boston, East Boston, Fenway, Hyde Park, Jamaica Plain, Mattapan, North End, Roslindale, Roxbury, South Boston, South End and Roxbury.

In addition to providing Paratransit service to the aforementioned more than 60 towns and communities, THE RIDE also has cooperative agreements with the Brockton Area Transit and with the MetroWest Regional Transit Authority

FIGURE 1
THE RIDE SERVICE AREA



to provide THE RIDE service to and from the main transit terminal in Brockton and the Wellesley Farms Commuter Rail Station. This also allows Brockton Area Transit and MetroWest Regional Transit Authority area residents to use their respective Paratransit service and then transfer to MBTA THE RIDE vehicles to travel to and from points in THE RIDE service area. In some instances of travel, transfers may be required. That is, a rider may be going from one area serviced by one contractor to another area serviced by another contractor. This is also the case with the above cooperative agreements. There are two transfer sites within THE RIDE's service area, they are: (1) Ruggles and (2) Malden/Medford. In both cases, transfers are necessary to provide more efficient service. For example, if a rider requests a trip from Salem to Concord, it is more efficient to have a vehicle transfer in Malden/Medford so that the vehicle coming from Salem operated by the Greater Lynn Senior Services can pick up another rider in the area that it services right after the drop off rather than driving all the way to Concord and then coming back into its service area to pick up another rider. If there were no transfers, there would be a lot of wasted time and miles in between each trip in such a case.

The US Department of Transportation's ADA regulations require that all transit entities, that provide complementary paratransit service, also have a process for determining who is eligible for ADA mandated paratransit services. In summary, the specific criteria stated in this regulation indicate that persons with disabilities are eligible for ADA required paratransit services if their disability:

- Prevents them from traveling to or from fixed route stops or stations;
- Does not allow them to use a bus route or rail station for a particular route or station;
- Does not allow them to "navigate" the systems without others' assistance.

Not only is it a requirement to have an eligibility determination process, but this process must also meet several regulatory requirements. These include the following:

- Interim service must be provided if determinations are not made within 21 calendar days of receipt of a completed application.
- A written notice must be given, once the decision on eligibility has been made. This notice includes the disclosure of specific reasons for denial or limit. This notice should also describe how the applicants can appeal the decision.
- An appeal process is required. Appellants must be given the opportunity to be heard in person and can have others provide information on their behalf. There must be a "separation of authority" between those involved in the appeal process and those involved in the initial determination. An appeal must be accepted within at least 60 days after the notice of the initial decision. That appeal must be decided within 30 days of the appeal hearing.

All drivers receive sensitivity and safety training so that they can respond in a responsible and proper manner. Drivers provide assistance into and out of vehicles and from and to the main entrance or lobby area of the rider's point of origin and destination, respectively. Drivers also assist individuals who use wheelchairs, at the rider's point of origin and destination, up a ramp of over a maximum of one curb and/or one step (several steps if a rider is ambulatory). In addition to this assistance, the driver will help the rider carry a manageable number of shopping bags to the door step of a rider's residence. This door-to-door service is customer-centric as it provides customized personal assistance. This assistance, however, creates less efficiency than a standard service. For example, the average time it takes for a vehicle to leave a pick up or drop off location is between 6 and 8 minutes. This is valuable time that could be used driving to the next pick up or drop-off location.

Each vehicle is equipped with Mobile Data Computers (MDC's) which contain a global positioning system (GPS); it disables touch screen while driving and has a radio for

emergency situations. It also has Auto Vehicle Locators (AVL's) that provide more accurate routes and data as well as lessen the radio time being used by each driver. This equipment provides the rider with a much more pleasant and safer trip. In addition, the AVL's provide the operators with real time vehicle location which makes it easier for the operators to alter a driver's route without his/her knowledge of a change. This control can be helpful due to the real time knowledge of whereabouts of the contractor's vehicles at any given time. The AVL can be further utilized in rerouting a vehicle to accommodate last minute trips as well as transferring a trip to a different vehicle which otherwise would have been missed or caused the contractor to have a late trip and therefore would be penalized for that trip.

The routing system is able to provide trip schedules based on a rider's requests. Once at 4 p.m. on the day before a deadline passes, a specialized routing program developed by Strategen Inc. schedules the trips for each contractor. There are a few common constraints by which each contractor must comply. These constraints include riding time, departure time, and arrival time constraints. The departure time requested by the rider must be met within 30 minutes of the requested time. The arrival time must be within certain parameters set by each individual contractor, but remains within the parameters of the rider's preferences. For example, a rider may want to arrive at his or her doctor's appointment at 9:00 a.m. The parameter is to arrive at the location by 9:00 am, but a contractor may set up a parameter in the software that requires the drop off at the location to be fifteen minutes before the required time so that the rider is not late for his/her appointment. The riding time constraints ensure that for a trip that takes less than 30 minutes to complete (direct time), the rider will not be in the vehicle for more than 60 minutes. If the trip takes more than 30 minutes to complete, the rider should not be in the vehicle for more than twice the required time for that trip.

Other required information, which is generally linked to a rider's profile upon receiving eligibility from THE RIDE, includes the needs of equipment (e.g., wheelchairs, scooters, and walkers) and service animals. Also, a rider must specify if he or she has a Personal Care Assistant (PCA) or a guest riding with him/her. The PCA can ride free of charge. PCA's and the guest must travel at the same time as the certified rider to and from the same destination. This information is important for the RIDE to ensure that a vehicle with appropriate equipment is dispatched to each pick up location, when routing vehicles with different types of wheelchair accessibilities.

On the day of the trip, the rider must be ready five minutes before his or her scheduled pickup and must be prepared to wait up to fifteen minutes after that time. The driver must wait for the rider for five minutes from the time of the scheduled pickup. If the rider is not at the pickup location within five minutes, the driver can obtain clearance from his/her dispatcher to leave. A rider is considered a *NO SHOW* if he or she fails to cancel his/her trip within one hour of the scheduled pickup or fails to show up within five minutes after the scheduled pickup time. If the driver does not arrive within fifteen minutes after the scheduled pickup time, the rider should call the Contractor for an Estimated Time of Arrival (ETA) or can reschedule his/her pickup at that time. If a driver is late 15 to 30 minutes, there is a 10% penalty of that total value paid to the Contractor for that trip. If a driver is late more than 30 minutes, the trip is not paid to the Contractor. These penalties force the Contractors to honor promised times, use the routing program, and make appropriate adjustments throughout the day to ensure timely pickups.

The phone system uses an Interactive Voice Response (IVR) system to callback riders once their trip has been scheduled with promised times for each pick up for the next day in the

scheduling program discussed above. These call backs occur the evening before the scheduled trips after the routing schedule has been produced by the software and prior to 9:00 p.m. The IVR is a system that takes all of the promised times from the schedule produced and automatically calls the riders to confirm these times. When the rider is on the phone, he/she can confirm or cancel his/her trip automatically. This provides a more streamlined system and in essence lowers costs further as discussed below.

There are many cost elements associated with the RIDE. These are mobilization costs, administrative overhead expenditures, and operational costs for each contractor. Mobilization costs include administrative personnel wages/fringes, rent, utilities, telephone, supplies, furniture/equipment, computer hardware, computer software, MDC/AVL, IVR, general insurance, vehicle operating expenses, communications system and profit. Mobilization costs exclude any and all capital expense. Administration and overhead expenditures include all amortized and capital expenses. Operational costs include driver salaries/fringes, vehicle maintenance, vehicle insurance, fees/licenses, and so forth. These costs also include fuel cost which is reimbursed to the Contractor for the actual price paid per gallon up to the average price per day in the Boston Metro Area, as listed via the AAA website. The Contractor is responsible for providing actual receipts for all gasoline purchases for services rendered, specifying whether receipts were for fuel purchases or for Authority owned or Contractor owned vehicles, adjusting the amount of reimbursement sought each month to ensure nothing exceeds the AAA recorded average per day and providing a summary report each month by day and by vehicle.

With all of these costs taken into consideration, the average net cost per passenger one way trip is \$41.61 for fiscal year 2010 (July through December 2009). As one can see, the fare of \$2.00 per each one way trip hardly covers the

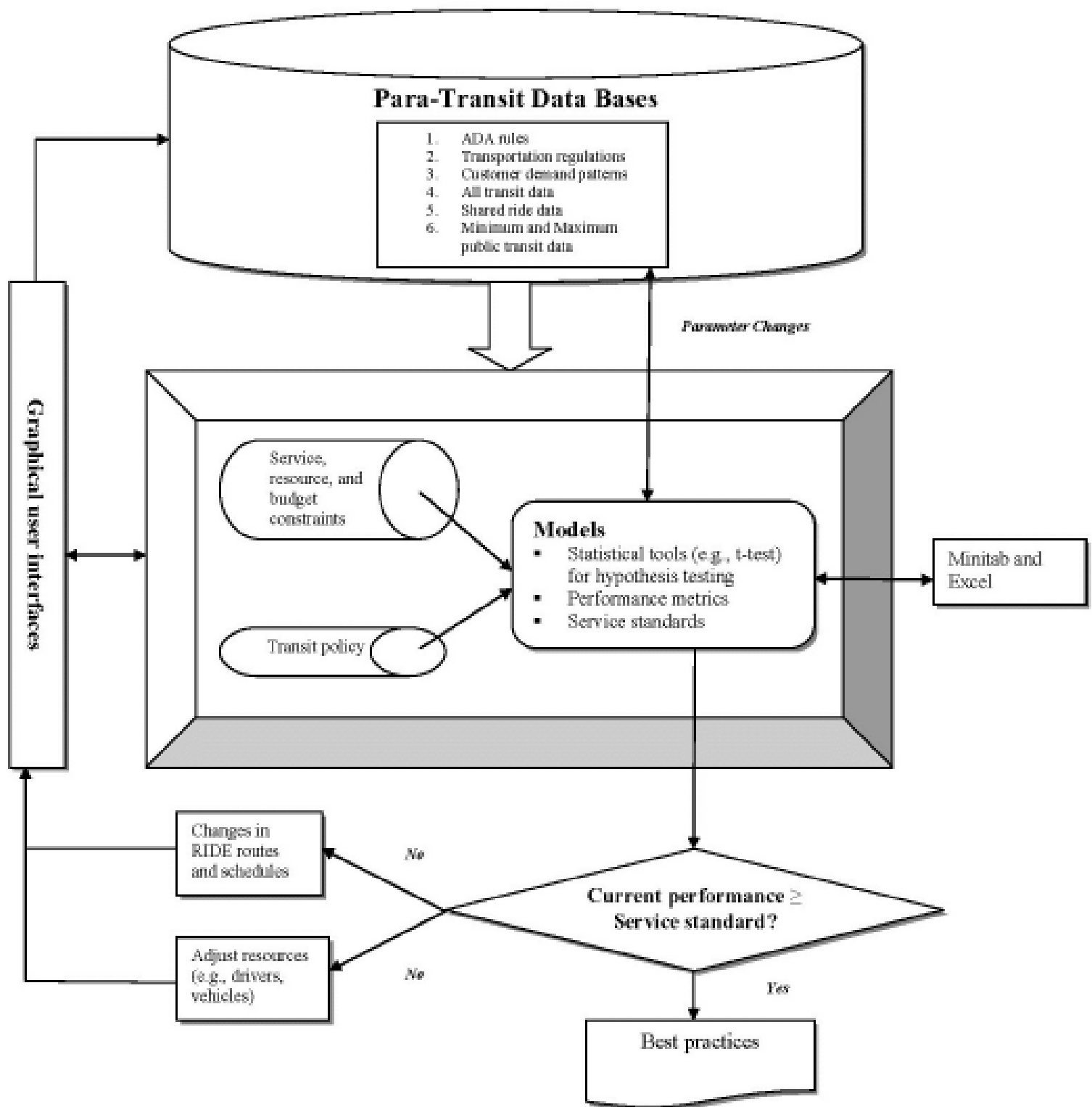
actual net cost of the trip (mere 4.8% of the operating cost). The fares that are not charged to PCA's even though a seat is taken are considered a cost that is being paid with no revenue to offset it. The aforementioned costs are also associated with the service that is provided to each rider. These services include meeting required pickup and drop off times, and personalized assistance provided by the drivers. The metrics of these services are discussed above and will now be summarized.

- The *maximum allowable riding time* is a standard used by Veterans Transportation Services to maintain the quality of paratransit services and is defined using the formula: The riding time may not exceed an hour if the direct drive time required for the trip is less than 30 minutes; else, the riding time may not exceed twice the direct drive time required if that time is greater than or equal to 30 minutes.
- Pickup times must be within 15 minutes of the promised time for the Contractor to avoid penalties. These penalties are considered savings to THE RIDE, but also incentives for providing the best customer service.
- Assistance provided by the driver includes carrying groceries to the door and assisting the rider to and from the door of their drop off and pickup locations, respectively. All of the aforementioned services and service parameters come at a cost to the Contractor, THE RIDE, and ultimately, taxpayers.

DECISION SUPPORT FRAMEWORK

To deal with a constant dilemma of making a trade-off between costs and rider service requirements, a decision support system (DSS) was developed. Its basic architecture is graphically depicted in Figure 2. As Figure 2 shows, the implementation of DSS begins with the development of data bases. Once necessary data are fed into the model which will be used to gauge the efficiency (both service and cost) of current paratransit services, the model outcome will be assessed to see if the current services are of acceptable quality. If dissatisfied with the

FIGURE 2
BASIC ARCHITECTURE OF THE DECISION SUPPORT SYSEM
FOR THE RIDE



paratransit service performance, the current paratransit route structures and schedules have to be changed while considering adjusting required resources (adding drivers, working overtime, and leasing/purchasing more vehicles under budget constraints). The impact of such changes on service quality and overall costs will be evaluated based on the summary of the outcomes in visual forms such as graphs and tables.

To demonstrate the usefulness of the aforementioned DSS framework, we first collected the actual data and then analyzed such data using statistical tools. The goal was to compare the quality of paratransit services to the public transit services. Paratransit ride data were provided by the Veterans Transportation Services contractor in two separate reports, both in Excel 2007 (.xlsx) format; (1) “Veterans – The Ride Manifest By Stop” printed 05/05/2010 at 18:30 and; (2) “MBTA Daily Posted Routes for 05/06/2010.” The Manifest By Stop contained all the planned trips for May 6, 2010 and the Daily Posted Routes contained all actual executed routes for May 6, 2010.

The first report provided, “Veterans – The Ride, Manifest By Stop,” included specific information on the Registered Passenger ID, Passenger Name, Requested Pickup and Drop-off Locations, Ambulatory information (i.e. whether a rider is able to walk or not), Wheelchair information, Equipment needs, Service needs, Additional Descriptions, and Directions and Notes. The ambulatory information is provided by a binary code. On the report it reads Amb: and then either a 0 or 1. If Amb: 0, then the rider is unable to walk; if Amb: 1, then the rider is able to walk. For noting whether or not a rider needs a wheelchair, it is similarly noted: WC: 0, if a wheelchair is not needed and WC: 1, if a wheelchair is needed. The next section is Equipment Needs which is denoted by the following and defined in parenthesis: A (Braces), C (Cane), R (Crutches), X (Extra Space), O (Oxygen), P (Power Chair), T (Prosthetics), S (Scooter), K (Walker), W (Wheelchair), TP (TTY Phone), TW (TTY

Work), I (Infant Car Seat), and B (Child Booster Seat). The Service Needs section was not utilized in this report. Additional Descriptions provided a section where the name of the actual location was typically given, i.e. the name of the hospital or rehabilitation center. Directions and Notes gave the driver additional information on how the rider may have wanted to travel ~~go~~, if the rider needed assistance to and from the door, what floor the doctor’s office is on, etc. In general, the additional information provided to the driver is to help better serve the riders to and from their requested locations.

The second report provided, “MBTA Daily Posted Routes for 05/06/2010,” included information such as the Registered Passenger ID, a unique identifier for each rider; the Trip ID, unique identifier for each trip; the Same Day Scheduling information denoted by “Yes” or “No;” the Passenger Name, Trip Disposition denoted by OK, Late16, Late30, No-Show, and Canceled. OK means that the driver arrived on time and the rider was picked up. Late16 means that the driver arrived more than 15 minutes later than the Promised Time, but not more than 30 minutes late to pick up the rider. Late30 means the driver arrived more than 30 minutes after the Promised Time, but still picked up the rider. No-Show means that the rider was not there within five minutes upon the driver’s arrival or failed to cancel the scheduled trip with at least one hour’s notice. If the driver arrives at the No-Show pickup location, the driver waited for the rider for five or more minutes and then acquired the clearance to leave. Canceled means that the trip was properly canceled and usually the driver is not even dispatched to that rider’s pickup location. Other information included in this report is Required Time, the time the rider requested to be picked up or the time at which it is necessary to be picked up to arrive at requested destination at a certain time; the Promised Time, the time the contractor has confirmed to pick up the rider; the Pickup Arrive Time and Pickup Leave Time are the times the driver arrived to pick up the rider and the time the driver left with the rider on board; the Drop

off Arrive Time and Drop off Leave Time are the times when the driver arrived at the location to drop off the rider and the time the driver left that location without the rider on board; the Pickup address and city, the Drop off address and city, Personal Care Assistant (PCA) information, Vehicle ID and Driver ID.

With the aforementioned information, the reports can be compared to one another to get a sense of how many changes in trips and routes are made after 6:30 p.m., i.e., cutoff time on the previous day. From the extent of changes being made, one can see how complicated it may become to rearrange routes and how necessary it is to have a reliable program to route the trips as well as an experienced staff to manually reroute vehicles according to the changes throughout the day. The changes a rider can make to his or her reservation include, but are not limited to time changes, pickup and drop off locations changes, cancellations, and no-showing for one's ride. Changes made to the routes throughout the day manually are caused by weather, traffic, road construction, and delays at pickup and drop off locations.

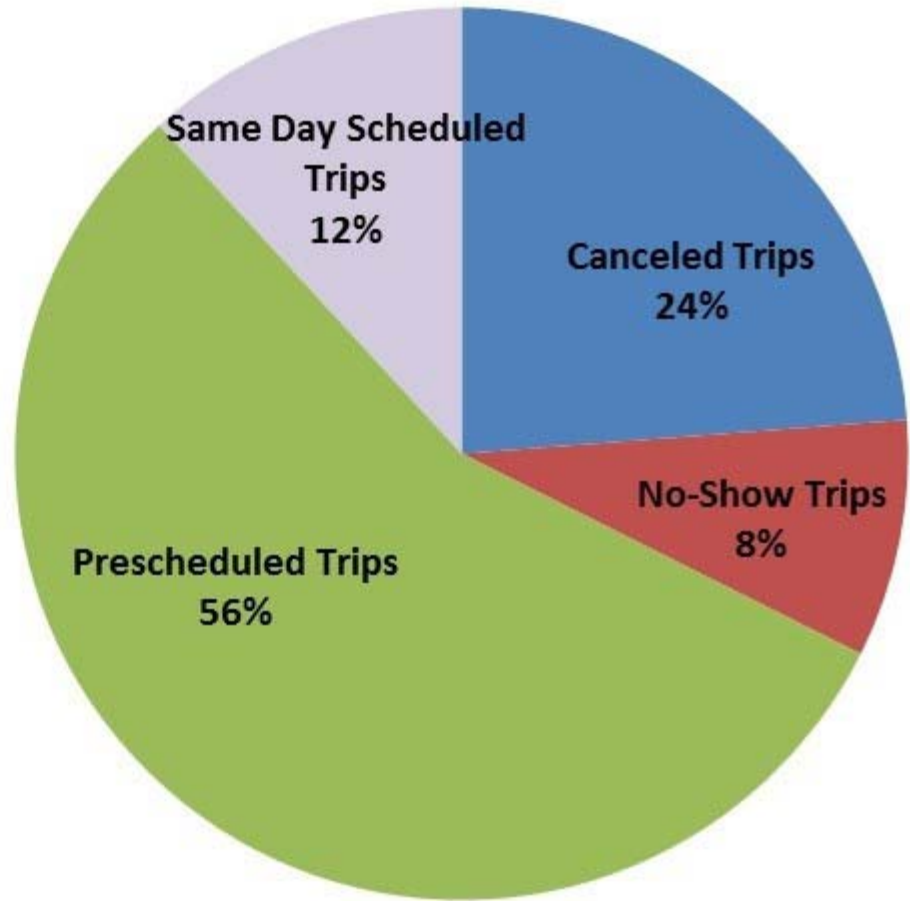
The Daily Posted Routes for 05/06/2010 contained data for all rides executed by Veterans Transportation Services on May 6, 2010. Each trip is a one way trip from an origin to a destination. There were a total of 2,376 completed rides for this day, comprised of 2204 on time completed trips, 164 Late 16 to 30 minute trips and 8 Late > 30 minute trips. The total completed trips were originally out of a total of 4,105 requested trips for this particular day, comprised of 836 cancelled trips, 303 No-Show trips, 2,754 On time trips, 202 Late 16 to 30 minute trips, and 10 Late > 30 minute trips. As it can be seen in the second set of data mentioned above, even if a trip is considered on time, it does not mean it was a completed on time trip and the same is true for late trips. Figure 32 below shows in a pie chart the proportion of rides and their outcomes discussed above with the addition of scheduled and prescheduled trips, i.e. cancelled trips, No-Show

trips, and executed trips that were either prescheduled or scheduled the same day.

The Manifest was used to determine the ambulatory status, wheelchair needs and to confirm the pickup and drop off locations of each rider printed in the Daily Posted Routes for May 6, 2010. If a rider was included in the Daily Posted Routes, but not in the Manifest, their ambulatory status was then undetermined and that trip would be eliminated from the data used for analysis. The rationale for eliminating these trips with missing ambulatory information is that for each trip to be analyzed, the information must be complete for each ride and therefore all data with complete information can be examined using the same tests and analyses.

For each trip, the minimum and maximum public transit times, direct drive times and mileage were determined. The public transit times were produced using MBTA's Trip Planner (http://mbta.com/rider_tools/trip_planner). By entering an origin and a destination, MBTA's Trip Planner generates several alternative itineraries (routes). The total trip time of a route typically consists of walking time, transit time on one or more transportation lines (subway or bus), and waiting time in case of transfers. A rider may select the route with the longest total public transit time (which usually has fewer transfers), the route with the shortest time (which usually has more transfers), or a route with total time in-between. To compare with the paratransit times, we selected the two extreme times, the minimum and the maximum public transit times. The direct drive times and mileage were found using Google Maps (<http://maps.google.com/maps?hl=en&tab=wl>). The data collection process of the public transit times and direct drive times along with mileage URL's was automated using a software program developed for this research to ease the manual process. The software program reads a set of origins-destinations from an Excel (.xlsx) spreadsheet to the web site and retrieves and stores the output data into the same spreadsheet. The collected data were subsequently checked

FIGURE 3
A CLASSIFICATION OF PARATRANSIT TRIPS



Cancelled Trips	836
No-Show Trips	303
Executed Prescheduled Trips	1960
Executed Same Day Scheduled Trips	416

individually to ensure their accuracy. The pickup and drop off locations of prescheduled trips were verified using the Manifest to ensure accuracy of the times. For each trip, it was determined whether or not it was a shared ride, if a wheelchair was needed for each passenger and the passenger's ambulatory status.

Once the minimum and maximum public transit times and the direct drive times were obtained, the data was then filtered to determine what data was viable for analysis. The exclusions were trip data for which public transit was not an option, data for which ambulatory information was not available for a particular rider, no shows, and canceled trips. There were also some trip data that were excluded due to a zero travel time, an unreasonable drop off arrival and/or departure or a blank drop off arrival and/or departure time. This type of data either indicated that the trip was canceled, a rider was a no-show or it was determined that the driver may have forgotten to indicate the drop off arrival and/or departure time. After the data was filtered for all criteria mentioned above, the result was 2,168 trips with viable and complete data to analyze.

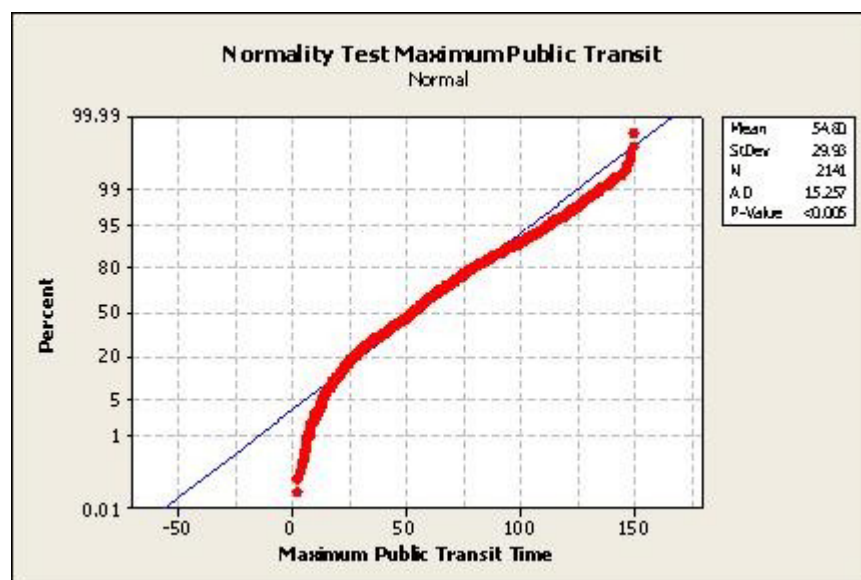
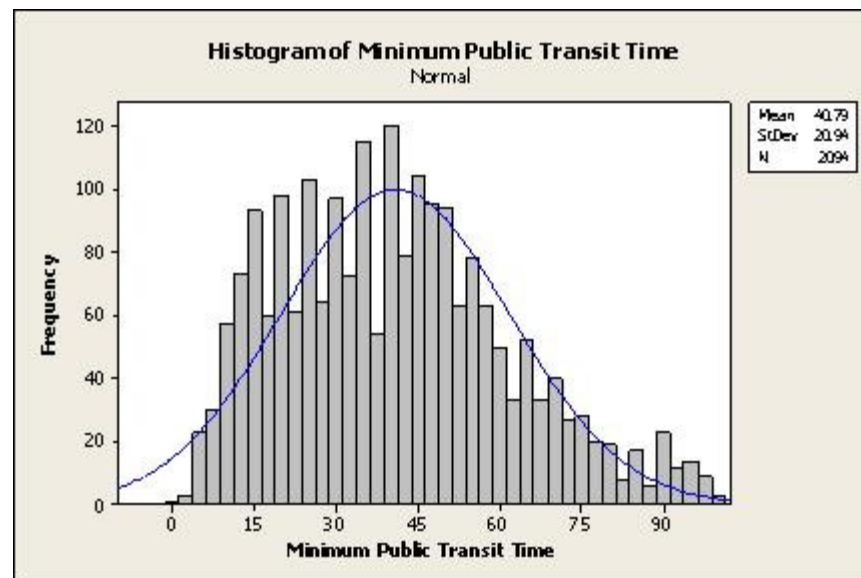
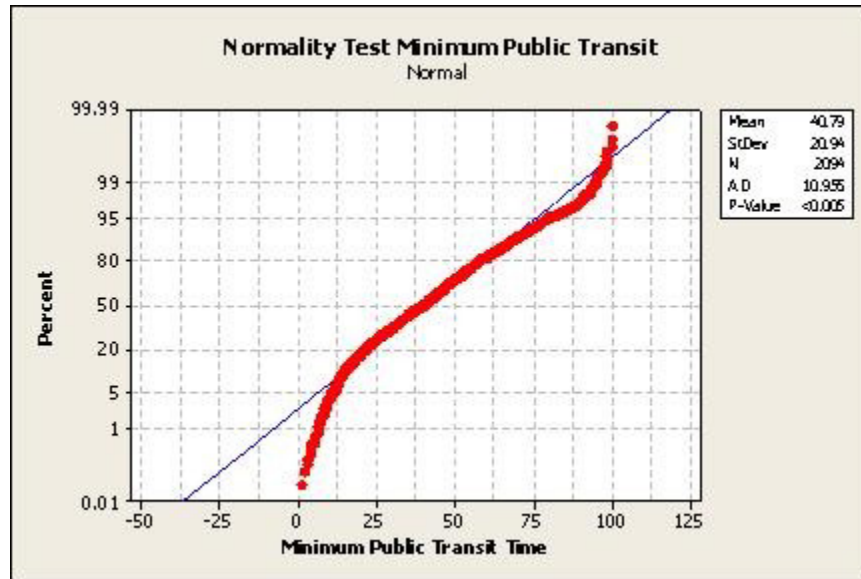
To compare the quality of paratransit services to the scheduled transit services, one can statistically compare the means of the transit times of rides of the two populations taken separately, i.e., paratransit rides and public transit rides. However, since we want to detect any significant difference due to the experimental process (paratransit versus public transit) and not due to experimental units (paratransit rides versus public transit rides), we should analyze the data in pairs. For each trip i , specified by the origin address and destination address, the difference of the realized paratransit time (x_i) from the minimum or maximum corresponding public transit time (y_i) was computed, i.e. $d_i = y_i - x_i$. The (x_i, y_i) is thus considered a pair of observations of two random variables (X, Y) and d_i an observation of their difference, $D = Y - X$. Taking expectations of both sides yields $\mu_D = \mu_Y - \mu_X$. In other words, we

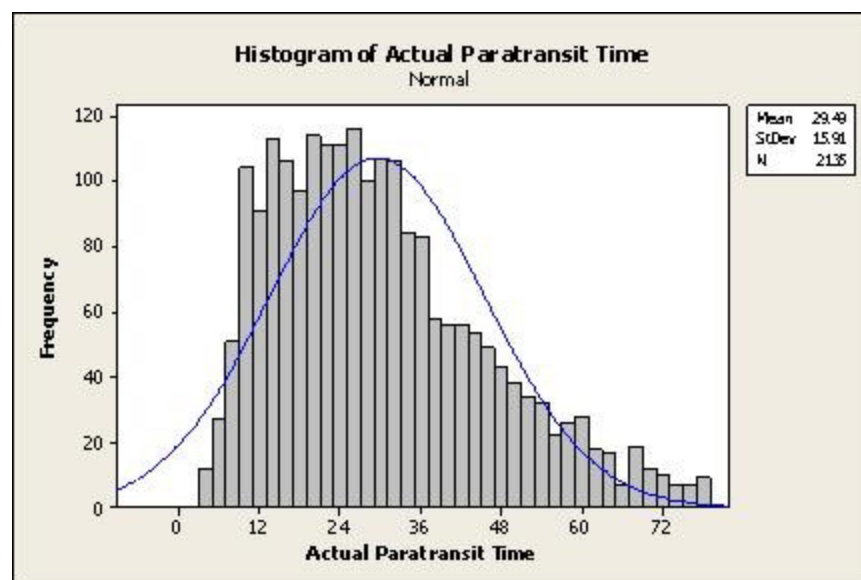
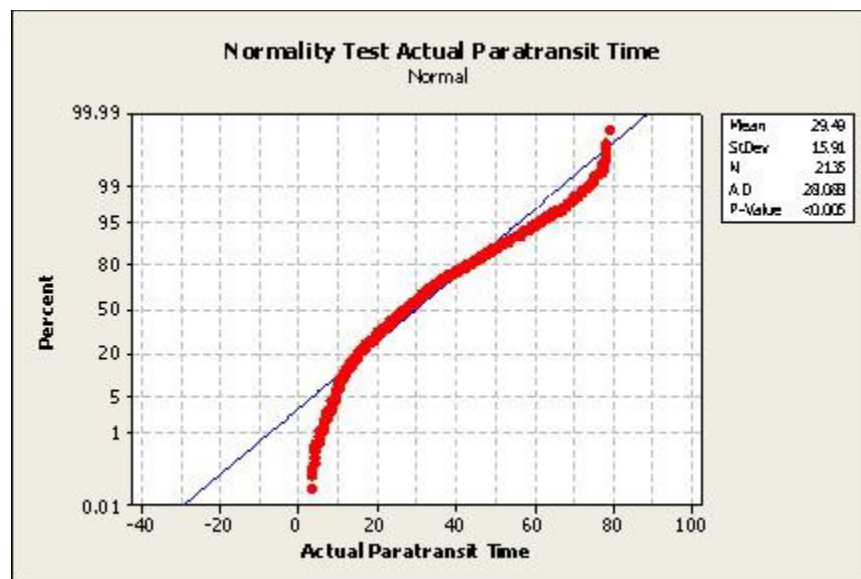
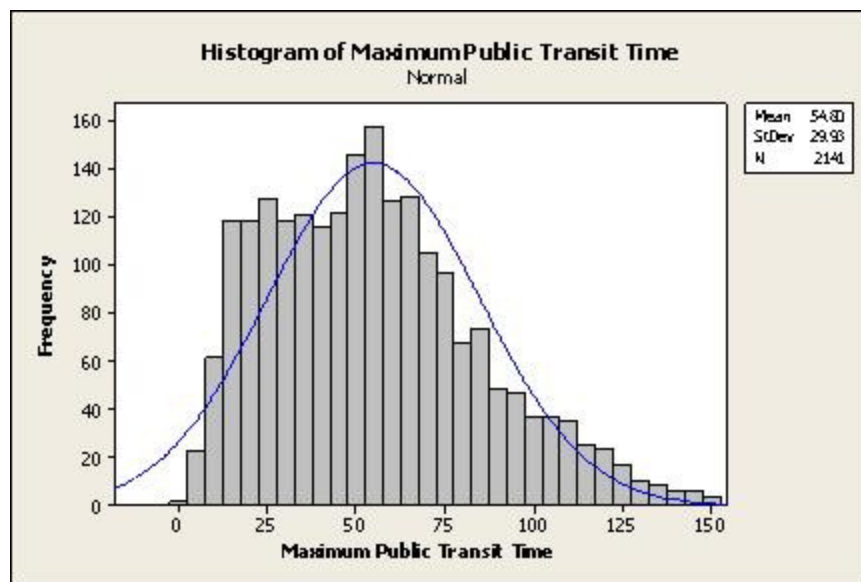
can make inferences regarding the difference of the means of the two populations ($\mu_Y - \mu_X$) by making inferences regarding the mean of the differences, μ_D . If the observations from each population are normal, the Student's t-statistic can be used to test a hypothesis about the difference in the means (Walpole et al., 2002).

Each data set of Minimum Public Transit Time, Maximum Public Transit Time, Actual Paratransit Time and Maximum Allowable Ride Time was tested for normality. Figure 4 contains the normal probability plots and the histograms for all data sets, obtained with Minitab statistical 15.1.0.0 software. As it can be seen, all data sets fail the normality test. However, even though the data sets do not fit the normal distribution, hypothesis testing could still be performed since the sample size is very large and the population is not very skewed. Under these assumptions the Student's t distribution gives a good approximation to the sampling distribution of the average difference D , (Levine et al., 2001). Hence the Student's t-statistic was used in hypothesis testing.

In this case, the *null hypothesis* (H_0) is that the difference of the means of the two populations (μ_D) is equal to a certain value v , i.e. $\mu_D = v$. The *alternative hypothesis* (H_A) is that $\mu_D > v$. The alternative hypothesis must be true if the null hypothesis is rejected. Hypothesis testing is designed so that the rejection of the null hypothesis is based on evidence from the sample that the alternative hypothesis is far more likely to be true (Levine, et al., 2001). By observing the descriptive statistics of the sample, v was selected to be 3 to 4 times the *standard error of the mean* lower than the *sample mean difference*. Several *Paired t-Tests* were conducted to determine how well THE RIDE is performing relative to the public transit system and to the maximum allowable riding time. Since shared rides are expected to have higher paratransit times than single rides, separate tests were performed for single rides, shared rides and all rides combined. All hypothesis tests were run using Excel 2007's t-test *Paired Two Samples*

FIGURE 4
A COMPARISON OF PUBLIC V. RIDE TRANSIT TIME PATTERNS





for Means and Minitab's 15.1.0.0's Paired *t*-Test. Running these tests took only seconds. The above two software provide the same results but different formats and statistical values that are useful when determining whether the test was run correctly and interpreting the results. This is shown in Tables 1, 2, and 3 for All Data, Single Rides, and Shared Rides, respectively, where all times are expressed in minutes.

The results from Minitab include the sample size N , the mean, the standard deviation, the standard error of the mean for each data set and the 99% lower bound for the mean difference. The Excel results give the mean, variance, sample size for each data set and the Pearson Correlation, Hypothesized Mean Difference, the degrees of freedom (df), the *t*-statistic, and several $P(T \leq t)$ and *t*-Critical values for level of significance $\alpha = 0.005$. The output from Excel and Minitab was used to verify the results of both as well as supplement the output with one another.

ALL DATA ANALYSIS AND RESULTS

All data included $N = 2,168$ viable rides, as discussed previously. The following three hypotheses were tested:

$D = X - Y$, where X and Y are defined below for each test.

- i. $X = \text{Minimum Public Transit Time}; Y = \text{Actual Paratransit Time.}$
 $H_0 : \mu_D = 11$
 $H_A : \mu_D > 11$
- ii. $X = \text{Maximum Public Transit Time}; Y = \text{Actual Paratransit Time.}$
 $H_0 : \mu_D = 24$
 $H_A : \mu_D > 24$
- iii. $X = \text{Maximum Allowable Ride Time}; Y = \text{Actual Paratransit Time.}$
 $H_0 : \mu_D = 28$
 $H_A : \mu_D > 28$.

The results are shown in Table 1. In the hypothesis test (i), for Minimum Public Transit Time vs. Actual Paratransit Time, the *t*-statistic is -3.84, the P-Value is 6.25×10^{-5} and the *t* Critical one-tail is -2.578. H_0 is rejected because

$t\text{-statistic} < t \text{ Critical one-tail}$ and the very small P-Value (very close to zero) strengthens the conclusion that the alternative hypothesis H_A is true ($\mu_D > 11$). In terms of paired differences, 99% of them are higher than 11.758 minutes (99% lower bound for mean difference) and 99.99% of them ($1 - P\text{-Value}$) are higher than 11 minutes. Therefore, the testing supports the statement that the average Actual Paratransit time of a trip is more than 11 minutes faster than the fastest (Minimum Public Transit Time) route for that trip.

Following the remaining test results of Table 1, one can conclude that on the average, Actual Paratransit (ii) is 24 minutes faster than the Maximum Public Transit Time; and (iii) exceeds the expectation of the Maximum Allowable Ride Time rule by 28 minutes.

Single Ride Data Analysis and Results

Out of the 2,168 total rides, there were $N = 1,290$ single rides. The following three hypotheses were tested:

$D = X - Y$, where X and Y are defined below for each test.

- iv. $X = \text{Minimum Public Transit Time}; Y = \text{Actual Paratransit Time.}$
 $H_0 : \mu_D = 16$
 $H_A : \mu_D > 16$
- v. $X = \text{Maximum Public Transit Time}; Y = \text{Actual Paratransit Time.}$
 $H_0 : \mu_D = 28$
 $H_A : \mu_D > 28$
- vi. $X = \text{Maximum Allowable Ride Time}; Y = \text{Actual Paratransit Time.}$
 $H_0 : \mu_D = 34$
 $H_A : \mu_D > 34$.

For the single ride data, the following conclusions can be drawn based on the output of Table 2: on the average, Actual Paratransit (iv) is 16 minutes faster than using the fastest Public Transit route; (v) is 28 faster than the longest Public Transit route; and (vi) exceeds the expectations of the Maximum Allowable Ride Time rule by 34 minutes.

TABLE 1
TEST RESULTS FOR ALL

Paired T for Min Public Transit - Actual Paratransit Time

	N	Mean	StDev	SE Mean
Min Public Transit	2168	43.426	25.163	0.54
Actual Paratransit	2168	30.503	17.902	0.384
Difference	2168	12.932	23.294	0.5

99% lower bound for mean difference: 11.758
T-Test of mean difference = 11 (vs > 11): T-Value = 3.84 P-Value = 0.000

t-Test: Paired Two Sample for Means

	Variable 1 - Min Pub Trans	Variable 2 - Actual Paratransit
Mean	43.42573801	30.50322878
Variance	633.1573806	320.4734552
Observations	2168	2168
Pearson Correlation	0.456205958	
Hypothesized Mean Difference	11	
df	2167	
t Stat	3.842786119	
P(T<=t) one-tail	6.25727E-05	
t Critical one-tail	2.578099976	
P(T<=t) two-tail	0.000125145	
t Critical two-tail	2.809912003	

Paired T for Max Public Transit - Actual Paratransit Time

	N	Mean	StDev	SE Mean
Max Public Transit	2168	56.496	34.27	0.736
Actual Paratransit	2168	30.503	17.902	0.384
Difference	2168	25.993	30.969	0.665

99% lower bound for mean difference: 24.444
T-Test of mean difference = 24 (vs > 24): T-Value = 3.00 P-Value = 0.001

t-Test: Paired Two Sample for Means

	Variable 1 - Max Pub Trans	Variable 2 - Actual Paratransit
Mean	56.49584871	30.50322878
Variance	1174.446683	320.4734552
Observations	2168	2168
Pearson Correlation	0.436696063	
Hypothesized Mean Difference	24	
df	2167	
t Stat	2.995870105	
P(T<=t) one-tail	0.001383831	
t Critical one-tail	2.578099976	
P(T<=t) two-tail	0.002767662	
t Critical two-tail	2.809912003	

Paired T for Rules for Max Paratransit Time - Actual Paratransit Time

	N	Mean	StDev	SE Mean
Rules for Max Paratransit Time	2168	60.07	0.7	0.015
Actual Paratransit	2168	30.503	17.902	0.384
Difference	2168	29.567	17.828	0.383

99% lower bound for mean difference: 28.675
T-Test of mean difference = 28 (vs > 28): T-Value = 4.09 P-Value = 0.000

t-Test: Paired Two Sample for Means

	Variable 1 - Rules for Max Paratransit	Variable 2 - Actual Paratransit
Mean	60.0701107	30.50322878
Variance	0.489775345	320.4734552
Observations	2168	2168
Pearson Correlation	0.124995861	
Hypothesized Mean Difference	28	
df	2167	
t Stat	4.092301428	
P(T<=t) one-tail	2.21376E-05	
t Critical one-tail	2.578099976	
P(T<=t) two-tail	4.42752E-05	
t Critical two-tail	2.809912003	

TABLE 2
TEST RESULTS FOR THE SINGLE RIDE DATA

Paired T for Min Public Transit - Actual Paratransit Time

	N	Mean	StDev	SE Mean
Min Public Transit	1290	42.656	25.111	0.699
Actual Paratransit	1290	24.649	13.159	0.366
Difference	1290	18.007	20.729	0.577
99% lower bound for mean difference: 16.663				
T-Test of mean difference = 16 (vs > 16): T-Value = 3.48 P-Value = 0.000				

t-Test: Paired Two Sample for Means

	Variable 1 - Min Pub Transit	Variable 2 - Actual Paratransit
Mean	42.65581395	24.64883721
Variance	630.5796597	173.1558753
Observations	1290	1290
Pearson Correlation	0.565964506	
Hypothesized Mean Difference	16	
df	1289	
t Stat	3.477381253	
P(T<=t) one-tail	0.000261594	
t Critical one-tail	2.579648826	
P(T<=t) two-tail	0.000523188	
t Critical two-tail	2.811875655	

Paired T for Max Public Transit - Actual Paratransit Time

	N	Mean	StDev	SE Mean
Max Public Transit	1290	55.011	32.835	0.914
Actual Paratransit	1290	24.649	13.159	0.366
Difference	1290	30.362	27.86	0.776
99% lower bound for mean difference: 28.555				
T-Test of mean difference = 28 (vs > 28): T-Value = 3.05 P-Value = 0.001				

t-Test: Paired Two Sample for Means

	Variable 1 - Max Pub Transit	Variable 2 - Actual Paratransit
Mean	55.01085271	24.64883721
Variance	1078.106942	173.1558753
Observations	1290	1290
Pearson Correlation	0.549763198	
Hypothesized Mean Difference	28	
df	1289	
t Stat	3.045033339	
P(T<=t) one-tail	0.001186866	
t Critical one-tail	2.579648826	
P(T<=t) two-tail	0.002373731	
t Critical two-tail	2.811875655	

Paired T for Rules for Max Paratransit Time - Actual Paratransit Time

	N	Mean	StDev	SE Mean
Rules for Max Paratransit	1290	60.076	0.689	0.019
Actual Paratransit	1290	24.649	13.159	0.366
Difference	1290	35.427	13.052	0.363

99% lower bound for mean difference: 34.581
T-Test of mean difference = 34 (vs > 34): T-Value = 3.93 P-Value = 0.000

t-Test: Paired Two Sample for Means

	Variable 1 - Rules for Max Paratransit	Variable 2 - Actual Paratransit
Mean	60.07596899	24.64883721
Variance	0.475217253	173.1558753
Observations	1290	1290
Pearson Correlation	0.180146608	
Hypothesized Mean Difference	34	
df	1289	
t Stat	3.927096267	
P(T<=t) one-tail	4.52645E-05	
t Critical one-tail	2.579648826	
P(T<=t) two-tail	9.05291E-05	
t Critical two-tail	2.811875655	

TABLE 3
TEST RESULTS FOR THE SHARED RIDE DATA

Paired T for Rules for Max Paratransit Time - Actual Paratransit Time

	N	Mean	StDev	SE Mean
Rules for Max Paratransit	878	60.062	0.715	0.024
Actual Paratransit	878	39.105	20.319	0.686
Difference	878	20.957	20.254	0.684

99% lower bound for mean difference: 19.364
T-Test of mean difference = 19 (vs > 19): T-Value = 2.86 P-Value = 0.002

t-Test: Paired Two Sample for Means

	<i>Variable 1 - Rules for Max Paratransit</i>	<i>Variable 2 - Actual Paratransit</i>
Mean	60.06150342	39.1047836
Variance	0.511606403	412.8784035
Observations	878	878
Pearson Correlation	0.109550166	
Hypothesized Mean Differer	19	
df	877	
t Stat	2.86269502	
P(T<=t) one-tail	0.002150299	
t Critical one-tail	2.581446873	
P(T<=t) two-tail	0.004300598	
t Critical two-tail	2.814155654	

Paired T for Min Public Transit - Actual Paratransit Time

	N	Mean	StDev	SE Mean
Min Public Transit	878	44.557	25.209	0.851
Actual Paratransit	878	39.105	20.319	0.686
Difference	878	5.452	24.806	0.837

99% lower bound for mean difference: 3.501
T-Test of mean difference = 3 (vs > 3): T-Value = 2.93 P-Value = 0.002

t-Test: Paired Two Sample for Means

	Variable 1 - Min Pub Transit	Variable 2 - Actual Paratransit
Mean	44.55694761	39.1047836
Variance	635.5149973	412.8784035
Observations	878	878
Pearson Correlation	0.422715869	
Hypothesized Mean Differer	3	
df	877	
t Stat	2.929160015	
P(T<=t) one-tail	0.001743422	
t Critical one-tail	2.581446873	
P(T<=t) two-tail	0.003486844	
t Critical two-tail	2.814155654	

Paired T for Max Public Transit - Actual Paratransit Time

	N	Mean	StDev	SE Mean
Max Public Transit	878	58.68	36.19	1.22
Actual Paratransit	878	39.105	20.319	0.686
Difference	878	19.57	34.05	1.15

99% lower bound for mean difference: 16.89
T-Test of mean difference = 16 (vs > 16): T-Value = 3.11 P-Value = 0.001

t-Test: Paired Two Sample for Means

	Variable 1 - Max Pub Transit	Variable 2 - Actual Paratransit
Mean	58.67767654	39.1047836
Variance	1309.374894	412.8784035
Observations	878	878
Pearson Correlation	0.382570761	
Hypothesized Mean Differer	16	
df	877	
t Stat	3.108848584	
P(T<=t) one-tail	0.000969397	
t Critical one-tail	2.581446873	
P(T<=t) two-tail	0.001938795	
t Critical two-tail	2.814155654	

Shared Ride Data Analysis and Results

Out of the 2,168 total rides, there were $N = 878$ shared rides. The following three hypotheses were tested:

$D = X - Y$, where X and Y are defined below for each test.

vii. $X = \text{Minimum Public Transit Time}$; $Y = \text{Actual Paratransit Time}$.

$H_0 : \mu_D = 3$

$H_A : \mu_D > 3$

viii. $X = \text{Minimum Public Transit Time}$; $Y = \text{Actual Paratransit Time}$.

$H_0 : \mu_D = 16$

$H_A : \mu_D > 16$

ix. $X = \text{Maximum Allowable Ride Time}$; $Y = \text{Actual Paratransit Time}$.

$H_0 : \mu_D = 19$

$H_A : \mu_D > 19$.

For the shared ride data, the following conclusions can be drawn based on the output of Table 3: on the average, Actual Paratransit (iv) is 3 minutes faster than the using the fastest Public Transit route; (v) is 16 faster than the longest Public Transit route; and (vi) exceeds the expectations of the Maximum Allowable Ride Time rule by 19 minutes. A summary of all hypothesis testing results is provided in Table 4.

Actual Paratransit Time vs. Direct Drive Time

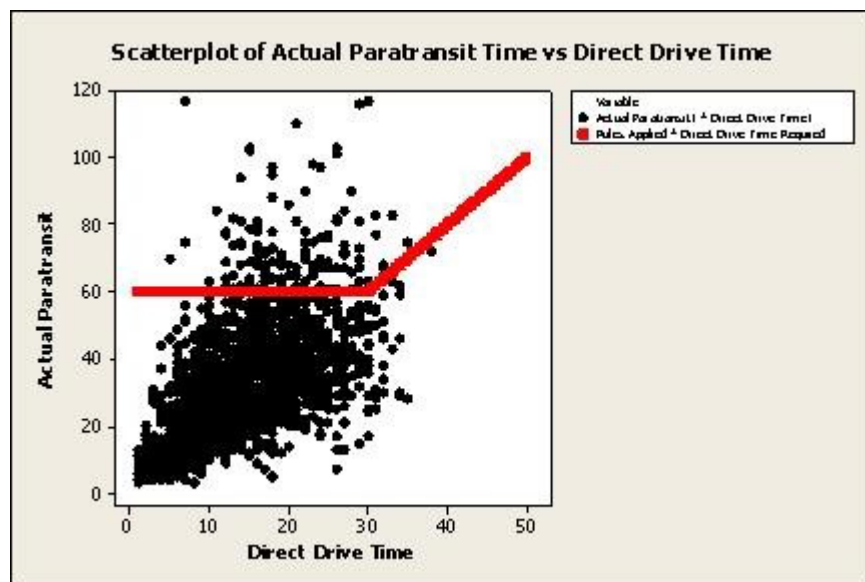
All trips that were executed by the Veterans Transportation Services contractor on 05/06/2010 are displayed as black bullets in Figure 5.

The coordinates of each bullet's center are the Actual Paratransit Time and the Direct Drive Time. The bent gray line, consisting of a horizontal segment (for *Direct Drive Time* ≤ 30 minutes) and an unbounded line segment with the slope of 1, divides the first orthant into two subspaces. Points that are above the line, inside the upper subspace, correspond to rides that violate the Maximum Allowable Riding Time rule. As it can be seen in Figure 5, there is not a significant amount of rides that violate the rule, calculated to be about 6.27% of all rides. Of Single Rides, Actual Paratransit Time exceeds the Maximum Allowable Time 1.78% of the time and of Shared Rides, Actual Paratransit Time exceeds the Maximum Allowable Time 12.87% of the time. This difference happens because when there are shared rides, it requires longer riding times for some passengers. For example, Rider A may be picked up at his or her origin location and before reaching his or her destination, the driver may pick up Rider B. If Rider B is dropped off before Rider A, Rider A has spent more riding time in the vehicle than he or she would have had it been a single ride where Rider A would have gone directly from his or her origin location to his or her destination. Overall, the 6.27% of rides being over the Maximum Allowable Time is not very many rides, considering the amount of rides completed per day. In total, for that particular day, it is 136 rides out of 2,168 of the rides in our data set.

TABLE 4
AVERAGE TIMES (MINUTES) PARATRANSIT RIDES ARE SHORTER

	All Data	Single Rides Only	Shared Rides Only
Min Public Transit	11	16	3
Max Public Transit	24	28	16
Maximum Promised	28	34	19

FIGURE 5
PARATRANSIT TIMES COMPLYING WITH THE MAXIMUM ALLOWABLE RIDE TIME RULE



Concluding Remarks and Managerial Implications

By comparing the Actual Paratransit Time to the Minimum and Maximum Public Transit Time and to the Maximum Allowable Ride Time, we concluded that THE RIDE is exceeding expectations by both being better or comparable to the public transit provided, having a slim chance of being late, and having a small chance of exceeding the maximum allowable riding time. In all cases, the average riding time was faster than taking the public transit, being it the Minimum Public Transit Time or the Maximum Public Transit Time, and the average riding time was significantly less than the Maximum Allowable Ride Time.

There are some adjustments THE RIDE could make in order to decrease costs. Since the rides that are provided are exceeding expectations and in some cases exceeding them considerably, we concluded that customer satisfaction is high while costs are high. In order to lower cost, customer satisfaction has to be sacrificed. For example, shared rides can be utilized more to

lower costs. More shared rides would mean employing fewer drivers, deploying fewer vehicles with lower fuel consumption, but would also mean longer riding times for riders and subsequently lower customer satisfaction.

If one was to look at All Data and the hypothesis testing summary results of Table 4, it can be seen that overall riding times are 11 minutes faster than Minimum Public Transit Times, 24 minutes faster than Maximum Public Transit Time, and exceeds the expectation of the Maximum Allowable Ride Time rule by 28 minutes. This can be interpreted as if there is 11 minutes or even 24 minutes that THE RIDE could be using and still be within the comparative requirements of public transit in the Greater Boston area imposed by the ADA rules. In the same respect, THE RIDE created 28 minutes of extra cushions for the Maximum Allowable Ride Times. This means that THE RIDE and/or its Contractors could loosen up some of their constraints in their DSS to allow for more shared rides and perhaps lengthen riding times slightly, but could potentially save some costs to run the program.

When looking at the Shared Ride Data, it turned out to be worse than both the All Data and Single Ride Data analysis where riding times are only shorter by 3 minutes against the Minimum Public Transit times and 16 minutes against the Maximum Public Transit times. Also, it is not as fast versus the Maximum Allowable Riding Time at about 19 minutes faster than the other categories. Because they are shared rides, riders endure longer riding times due to the scheduling of pickups and drop-offs that are not consecutive to each rider. It may cause concern to allow more share rides for customers, but may make sense for cutting costs as even the shared rides are exceeding expectations and paratransit service is quite comparable to public transit whether be it the minimum or maximum public transit times.

In the same notion, with regards to the Single Ride Data, it can be seen that these times are significantly better than All Observations and Shared Ride Data. For Single Ride Data, the overall riding times are better than Minimum and Maximum Public Transit Times by 16 minutes and 28 minutes, respectively. The Single Ride Data is running about 34 minutes faster than the Maximum Allowable Riding Times. It is very clear in this case that allowing for more shared rides could lower costs while maintaining an acceptable level of customer service. In general, THE RIDE and its Contractor, Veterans Transportation Services, are performing very well when all the Paratransit services are compared. It is apparent that THE RIDE is comparable to quality of the public transit service provided locally. In other words, THE RIDE passes the performance test with flying colors and gives room for further cost savings, while abiding by the Maximum Allowable Riding Times rule.

Learned from the successful implementation of THE RIDE, other transit agencies may exploit the proposed DSS framework. There are three key elements for a successful implementation of the DSS for transit agencies:

- 1) Development and periodic update of accurate para-transit databases;
- 2) Incorporation of pertinent transit knowledge (e.g., transit policy) and appropriate problem solving tools (e.g., operations research and statistical techniques) into model bases;
- 3) Creation of user interfaces with both data and model bases to provide actionable alerts, problem diagnosis, and decision alternatives on a real-time basis.

As evidenced by THE RIDE, the proposed DSS can help the transit agency significantly enhance its para-transit services and reduce operating costs by automating routing/scheduling procedures and making timely and structured information available to transit authorities.

Acknowledgements

The authors thank Paul Strobis and Carol Joyce-Harrington of MBTA's Office for Transportation Access for providing access to the RIDE data. This research was partially supported by the U.S. Department of Transportation, Research and Innovative Technology Administration - grant MIOH UTCTS13, and the University Transportation Center (UTC) at the University of Detroit-Mercy.

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MAKING TRANSPORTATION OPTIONS POSSIBLE

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ABSTRACT

Transportation options provide the buyer the right, but not the obligation, to buy or sell transportation capacity at a future date. These options can provide shippers, carriers and logistics companies a significant opportunity to reduce risks and increase capacity flexibility. This paper summarizes some of these benefits, describes a number of issues to be resolved before trading transportation options can become a reality, and presents possible resolutions for these issues.

INTRODUCTION

In 2006, Tibben-Lembke and Rogers presented the concept of transportation options, a new tool for providing flexibility for supply chain managers. Despite the fact that transportation options are not currently traded, this proposed concept has already been discussed in the supply chain press (Lynch, 2007). Firms have begun looking to hedge their transportation risk, and since financial derivatives are utilized to ameliorate the risk of physical commodities, we believe applying them to transportation could provide managers an additional tool to manage costs.

As described in detail below, transportation options would be quite similar in many ways to stock options and other financial derivatives. A primary function of financial derivatives is for one party to pay another participant to assume some risk. Transportation options would work similarly to stock options in this regard. For example, if a shipper bought an option to ship an item at a future date for a given price, they have eliminated the risk of needing to pay a higher price for that transportation at the time of the transaction. In exchange for the payment they receive, the option seller agrees to accept the risk of price increases, because the seller believes that the price will not rise to the extent that the purchaser of the option believes is likely. Given the sources of uncertainty companies face (access to capacity, fuel prices, driver shortages,

etc., etc.), and the possibility for options to reduce these risks, we believe using options to hedge transportation costs could provide significant opportunities for parties at all stages of the supply chain: shippers, carriers, and 3PLs.

Although we will refer to the provider of the transportation service as a “carrier,” we believe that transportation options could potentially be written for any transportation modes such as truck, ocean, air, rail, pipeline, or power line. Additionally, the transportation provider could be a non-asset-based third party such as an NVOCC.

In fact, some forms of options have been traded on ocean shipping capacity since 1985 (Gray, 1987, Alizadeh and Nomikos, 2009), when the Baltic International Freight Futures Exchange (BIFFEX) futures contracts were created, trading on the 13 routes defined in the Baltic Freight Index (BFI). Multiple sizes of ships and types of cargoes are now included. The statistical relationships between the lanes and cargo types have been widely studied (Haigh et al., 2004, Nomikos and Alizadeh, 2002). These indices have allowed shippers and carriers to manage their risks and have found acceptance in the ocean shipping world. We believe that a method for hedging and managing other types of transportation risk could provide similar benefits. Below, we address many of the issues that must

be considered before transportation options can be widely traded, present possible solutions for many of these issues, and provide a list of areas where future work is still needed.

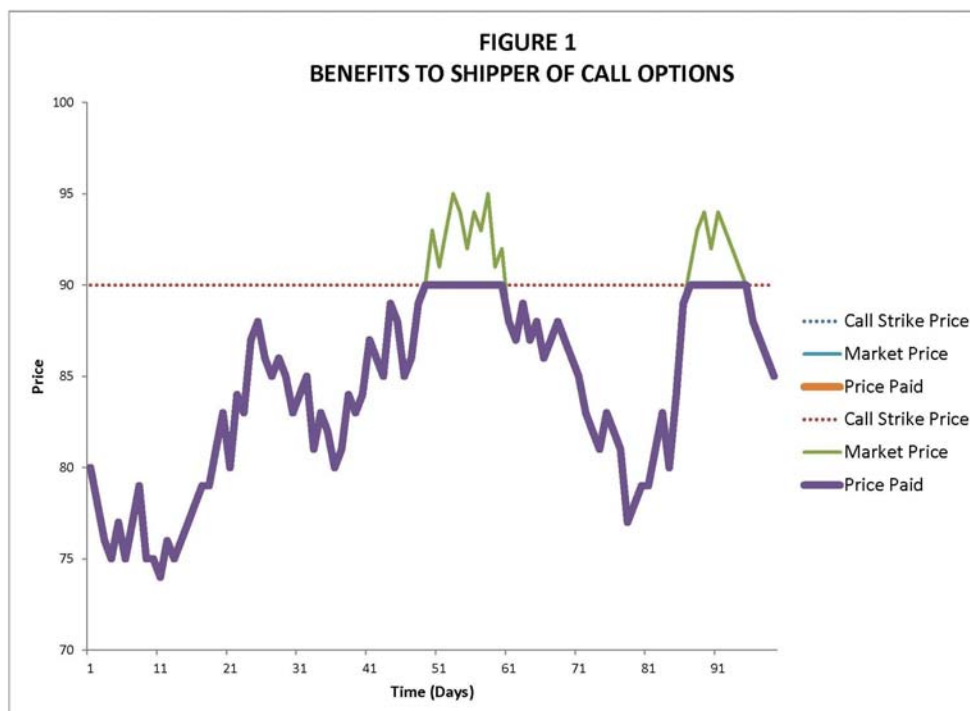
HOW TRANSPORTATION OPTIONS COULD WORK

A transportation option would be similar to a stock option, and like a stock option, could come in the form of both “puts” and “calls.” For stocks, a call option allows the purchaser to buy the stock at the specified price, which is called the “strike price.” This strike price means the investor will be able to purchase the stock at a guaranteed price. Between the time that the option is purchased and the exercise or strike date, the market price may rise above the strike price, in which case the option will be exercised because the investor can buy the stock more cheaply than the market price and immediately sell it at a profit, or fall below the strike price, in which case the option will not be exercised. In either case, the option allows the manager to reduce the uncertainty of future returns. If the option may be exercised at any time prior to the exercise date, it is known as an “American”

option, and if it may only be exercised on the specified date, it is known as a “European” option (Kolb and Overdahl, 2007).

A transportation call option would give the shipper the right to ship a given quantity on a specific lane on a given date in the future. If shippers are uncertain about the ability to get access to transportation capacity in the future, or would like to lock in transportation prices for the future, they might be interested in purchasing call options. With a truckload (TL) call option, if the shipper decides against exercising the option, the carrier does not send the truck. This is analogous to the case of the stock option: if the buyer of the stock option decides not to exercise the option, the option seller keeps possession of the stock.

As shown in Figure 1, if a shipper buys a call option, and the market price goes above the strike price, the shipper will never pay a price higher than the strike price, protecting the shipper from upward price movements. The heavy line in Figure 1 depicts the price the shipper would pay. If the market price exceeds the strike price, the shipper would only pay the



strike price of the call option. At the same time, the call option seller (also called the “writer”) is now guaranteed that it will never see revenues greater than the strike price.

A put option on a stock gives the holder the right, but not the obligation, to compel the seller of the option to take possession of the asset and pay the specified price. A put option would give the carrier the right to haul a shipment on a particular date. In a transportation option, a put option would be similar, in that the holder of the put option would have the right to compel the option’s seller to take temporary possession of the asset and pay the specified price.

BENEFITS OF TRANSPORTATION OPTIONS

Transportation options can provide a number of different kinds of benefits for all of the participants in the transportation marketplace. Both shippers and transportation providers face uncertainties that could be hedged through the utilization of options. These risks include problems such as increasing or decreasing fuel costs. Options could ameliorate risks such as capacity problems that happen during the period leading up to the Christmas season. Long term negotiated contracts with carriers that can be locked in for heavy freight lanes are useful to manage uncertainty, but contracts with carriers often include volume requirements or implied freight levels to receive the negotiated pricing. Options would be useful for both heavy freight lanes and for lower volume and less repetitive moves. If a driver or equipment shortage develops, or threat of a strike similar to the one that UPS faced in 1997 (Brannigan and Mathews, 1997), using options could allow shippers a steady supply of transportation capacity.

Removing Sources of Risk

There are many sources of uncertainty for shippers, carriers, and third party logistics service

companies whose risk could be reduced through the use of options. For example:

- Access to capacity in tight markets or lanes due to seasonal fluctuations (e.g. pre-holiday shipments)
- Access to capacity in tight markets or lanes due to cyclical fluctuations (e.g. driver shortages)
- Fuel price risks
- Economic fluctuations (e.g. a booming economy means all transportation capacity is tight)
- Equipment positioning imbalances (e.g. due to product flows, equipment is available in a location but is unavailable where it is required)

In 2006 through 2008, there were numerous reports of a tight supply for truck drivers in the U.S. and Europe (Ajlouny, 2006; Lynch, 2006). As the price of diesel spiked in the summer of 2008, and the economy slowed later in that same year, a large number of trucks were taken out of service and shipped to places such as Eastern Europe (Calabrese, 2008). As the economy continues to recover, there may be capacity issues. In Europe, new laws mandating the tracking and monitoring of driver behavior are expected to further tighten the supply of drivers (Zuckerman, 2008). When transportation capacity is tight, costs could be expected to rise, and if options can provide an ability to reduce the risk of paying higher shipping costs, they should be quite attractive for shippers.

In the summer of 2007, a U.S. consumer goods company paid a large 3PL above-market rates in order to have guaranteed access to transportation capacity before a major holiday. The shipper paid the full above-market price, regardless of whether it used the capacity or not. If the shipper would have had the choice to just buy an option for that capacity, it would have been much better off: it would have had the same guaranteed

access to capacity, but at a much lower cost (Sanders, 2010).

One large source of uncertainty for supply chain firms is uncertainty in fuel prices. In recent years, the price of fuel has varied significantly. Although carriers have some ability to protect themselves through the use of fuel surcharges, shippers have no such ability, and call options could protect them from the risk of rising prices. By buying a call option, the shipper ensures that it will never pay a higher price for the capacity than the strike price of the option. Figure 2 shows the fluctuation in prices for No. 2 diesel fuel over the past 20 years from March of 1994 through February of 2014 (EIA, 2014).

Although prices have climbed steadily over this time period, there has been a significant amount of short-term fluctuation within that period, as well. Figure 3 shows how much prices changed over a rolling four week period. For example, in September, 2005, diesel prices were 20% higher than they had been just four weeks earlier. Then, in November, prices fell 20% compared with where they had been just four weeks prior. Clearly, fuel prices can change significantly in a short period of time.

U.S. economic variability can be a source of significant fluctuations in the price and availability of transportation capacity. As U.S. demand for goods manufactured overseas has increased over recent decades, access to transportation capacity has become an increasingly critical resource for retailers, distributors and manufacturers. Cyclical increases and decreases in the U.S. economy can have a significant impact on the demand for transportation capacity. In 2007 and 2008, the declining value of the U.S. dollar increased U.S. exports (New York Times, 2008).

Financial Benefit of Call Options For Both Parties

In order for options to be traded, they have to be attractive to both carriers and shippers. As discussed above, a call option allows shippers to purchase the benefit of not worrying about transportation costs increasing beyond the strike price. Regardless of whether they use the option or not, they benefit from its existence.

A call option also has to benefit the carrier. If the value of the premium from selling a call option is enough to stimulate the carrier to sell, then the option will be perceived to be profitable. Consider, for example, a single-driver load

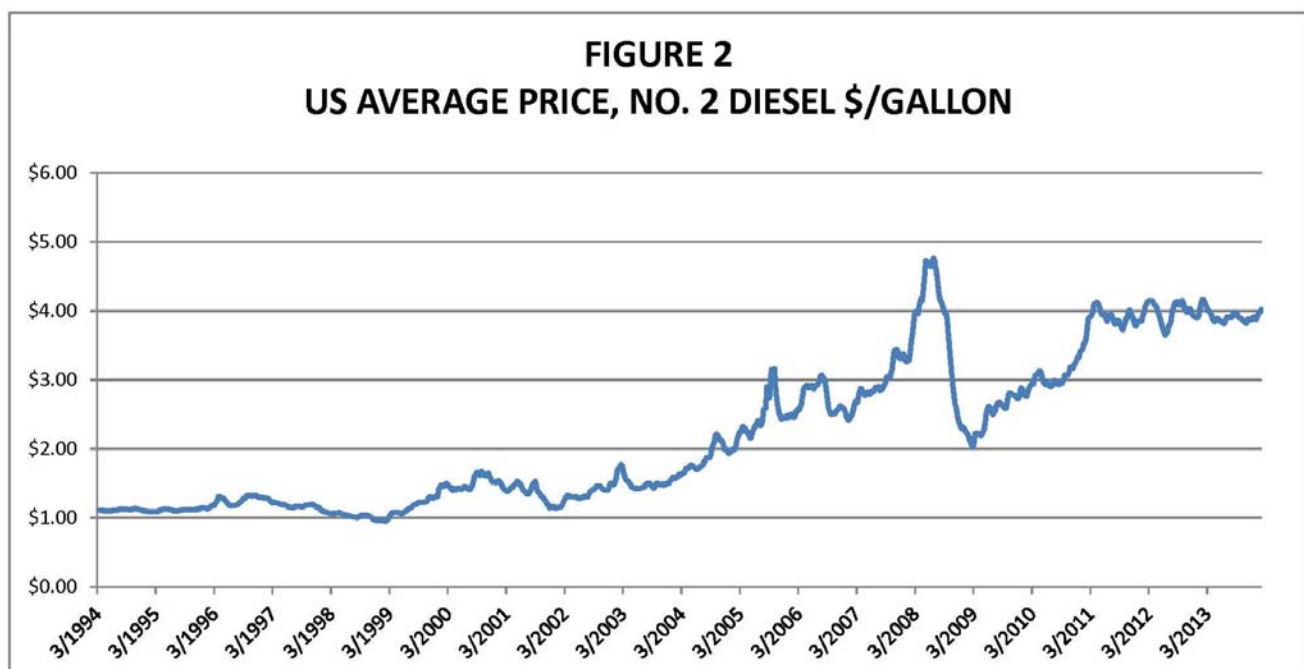
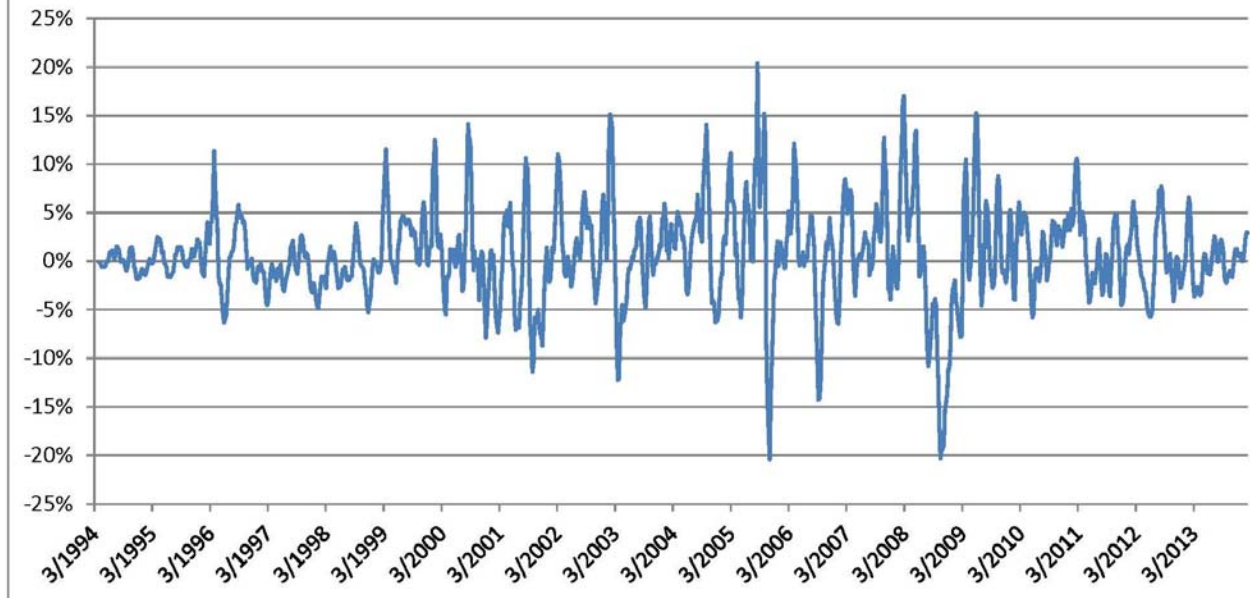


FIGURE 3.
DIESEL PRICE VARIABILITY- 4 WEEK PRICE CHANGES



from the Port of Los Angeles to Chicago. In early March 2014, a spot-market quote for two weeks in advance was \$3,179 (Freightquote, 2014). For the carrier, suppose gross margins are 10%. So the carrier's costs for the shipment would be \$2,861 and gross profit is \$318. If the shipper bought the option from the carrier for \$75, that would be a 24% increase in the carrier's gross profits from the shipment. Even if the shipper does not use the truck, the carrier keeps the \$75 payment. The lower the carrier's margin, the greater the percentage increase in profits from the option premium. For example, if the carrier's margins were 5%, (\$159), the \$75 option premium would represent a 47% increase in profits for the carrier.

If the spot market price rises to above \$3,179, the shipper would exercise the option. If the spot market price is \$3,254, the carrier's revenues are the same as if there had been no option, receiving a payment of \$3,179 for the shipment, plus the \$75 option fee, and still makes its profits \$318. If the market price rises above \$3,254, the carrier receives less profit from having sold the option than it would have if it had not sold the option. If the market price has increased because of supply imbalances or short-

term driver shortages, the carrier's costs (of \$2,861) would likely not increase, and the carrier's original profit of \$318 remains intact. If the carrier's costs have not increased significantly, the carrier's profit is unchanged by the rising market price, because the revenues and costs are unchanged. If the price rises higher, the carrier is not making as much profit as it could make at the market price, but is still making the profits of \$318.

However, this is less profit than the carrier would receive from carrying the load at the higher market price, but the original profit has not been forfeited. If fuel or labor costs increase, the carrier's costs must increase above \$3,254 before the carrier will actually lose money by carrying the load for \$3,179. That would be a cost increase of \$393, almost 14%.

PRICING TRANSPORTATION OPTIONS

Deciding on the price for buying or selling an option is clearly important. Sophisticated models would be required, based on historical data and economic projections, to figure out how much a company should be willing to pay for an option.

In a way, transportation options are like an insurance policy a shipper can buy to guarantee the price to be paid will not exceed a given value. With insurance, companies charge a premium to take on risk for the company. The premium is set at a point where the policyholder feels the benefit in reduced risk exceeds the premium, and yet at a point that the insurance company can make a profit by pooling the risk of insuring a large number of policies. In much the same way that the actuarial field has been developed to set insurance premiums, and options pricing models have been developed to set premiums for stock options, a mathematical study of transportation options pricing is also required.

In the stock exchanges and commodities markets, derivatives have been successful. The primary reason for their success is that they have attracted many different types of traders, and they increase liquidity in the market. The trader can control a large amount of stock with a minimal stake. When a trader wants to take one side of an options contract, there is usually no problem finding another trader that is willing to take the other side.

USING PUT OPTIONS

In a stock transaction, a put option gives the holder the right, but not the obligation, to require someone to take possession of the asset and pay the specified price for the asset. If the price of a stock falls below the strike price, the option holder would exercise the option, forcing the option seller to buy the stock at the above-market strike price. In a transportation option, a put option would be similar, in that the holder of the put option would have the right to require the put option's seller to take temporary possession of the asset and pay the specified price. For example, suppose a shipper sells a put option to a carrier to move a load on a given lane for \$1,500, and suppose the carrier pays \$100 to the shipper for this option. This gives the carrier the right to require the shipper to use the

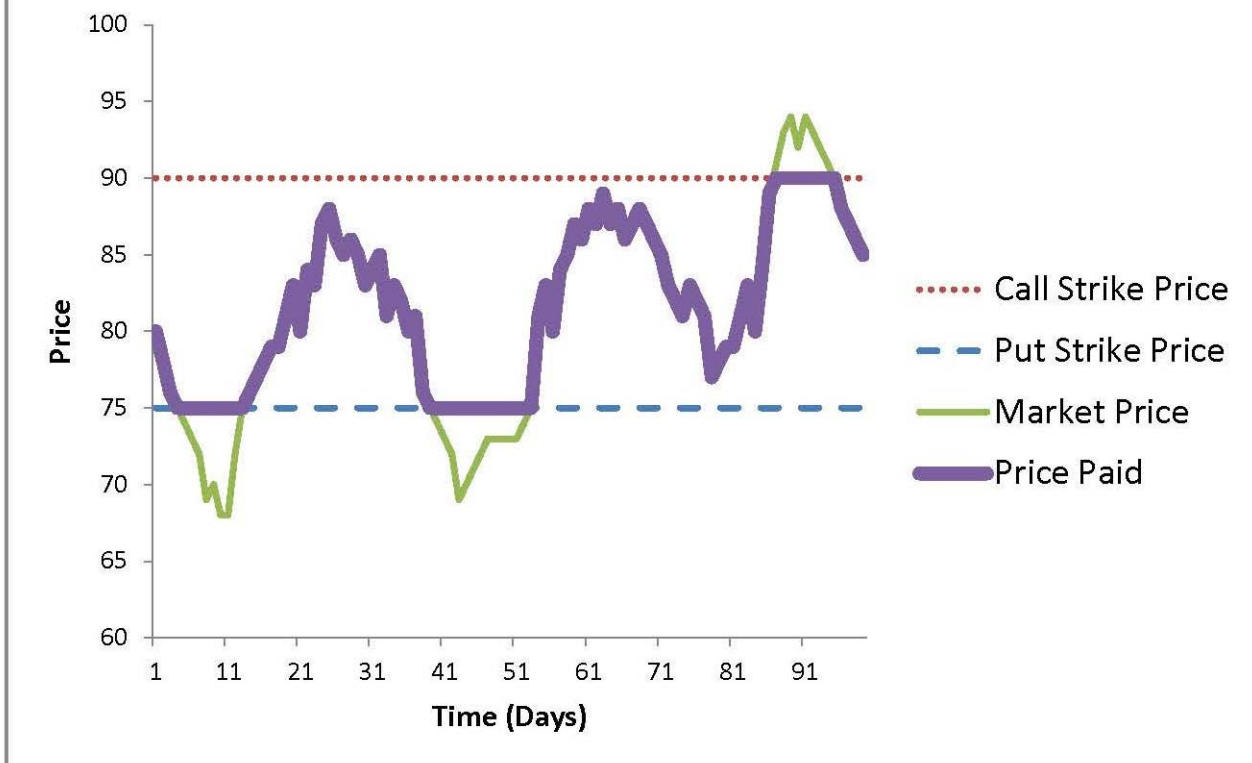
carrier's trucks at that price. Suppose the spot market price for the lane is \$1,300 on the option's strike date. The carrier would decide to exercise the put option, which means that the shipper is obligated to use the truck on the lane and pay \$1,500 to the carrier. If the spot market price were above \$1,500, the carrier would not exercise the put option, because the carrier can receive a higher payment on the spot market. This guarantees the carrier a revenue stream, which is why it would buy a put. From the shipper's perspective, if the spot market price is below \$1,500, the shipper will be forced to pay above-market rates for the lane, because it sold this put option.

The shipper is essentially selling an insurance policy to the carrier, protecting the carrier against the possibility of rates being too low. The shipper must carefully consider its beliefs about future prices, in order to properly put a price on how much it wants to receive in order to be willing to sell the put option. If a shipper thinks there is a realistic possibility that the market price will not be below \$1,500, the shipper should consider the possibility of selling a put option.

If the carrier thinks that fluctuations in demand for trucks on the lane and fluctuations in the price of fuel make it a realistic possibility that the spot market price might be below \$1,500, the carrier should consider the possibility of buying the put option. The amount the carrier would be willing to pay for this risk protection will depend on its tolerance for risk, and its beliefs about future prices.

Another reason for using put options is to bound the risk realized by a call option. As depicted in Figure 4, if a carrier or 3PL sells call options to shippers, it places a cap on the highest price it can expect to receive for that service. If a carrier or 3PL buys a put option that places a lower bound on the price that it will receive. In Figure 4, both the upper and lower bounds provided by a call option and a put option are shown.

FIGURE 4
CARRIER OR 3PL USING PUT OR CALL OPTIONS



Thus, carriers or third parties have a reason to consider buying a put option, and shippers have a reason to consider selling a put option. For both, the put option represents a type of insurance policy, or hedge, protecting the firm against unfavorable prices in the spot market. In order for a transaction to take place, the amount of protection offered must be sold for a price both think represents a fair price.

OPPORTUNITIES FOR 3PLS

Many transportation transactions are facilitated through a non-asset based third party logistics provider (3PL). A put option would work well with a 3PL positioned in between the shipper and the carrier. One of the duties of the third-party is to match and consolidate supply and demand for capacity, charging a commission for the service. If transportation options became a reality, the 3PL could benefit by selling financial derivatives to both sides in addition to transportation and logistics services.

To some extent, a logistics third-party acts similarly to a stockbroker: a stockbroker advises clients on which investments to make and when, and the 3PL advises shippers about which carriers to use and when. A 3PL may also act like a stockbroker by suggesting opportunities, providing predictions about the future state of the market, and helping the client firm decide when to lock in long-term pricing.

A 3PL could guarantee lower maximum prices for its shippers by buying call options from its carriers. If one particular shipper does not need the capacity, perhaps one of the many other shippers will. Similarly, it could sell put options to its carriers. When the carriers don't exercise the puts, it can bank the premiums. When the carriers do use the puts, it can use the premiums to offset the higher rates.

In the current environment, when a 3PL is responding to a bid, it has to tell the customer

that it has no way to know for sure what the prices are going to be in the future. Typically, a third party or a carrier will write a contract that allows them to place transportation surcharges on the shipper. If the 3PL could buy or sell options, it would be more able to protect both its customer and its transportation supplier. By buying call options, the 3PL could offer its customers guaranteed freight rates, which would be a competitive advantage. Currently, 3PLs are often on “both sides of the table,” buying and selling transportation capacity. 3PLs might find options a valuable way to reduce the risk exposure to customers, suppliers and themselves. On the other hand, a 3PL may believe that it has sufficient capacity reserves to be able to absorb the market risks of other companies, and it may choose to sell options.

POSSIBLE RISKS OF FINANCIAL DERIVATIVES

Because much of the credit crisis of 2008 was related to financial derivatives, description of the potential risks of transportation options is in order. Also, because there was widespread belief that speculators had significantly affected the price of oil, we will attempt to address the possibilities for transportation options to be similarly affected by speculation.

First of all, the authors do not believe that transportation options will provide any significant risk to the transportation markets. Much of the “subprime meltdown” of 2007 and “credit crunch” was exacerbated by the heavy use of complicated risk derivatives in the financial markets (Mizen, 2008). The use of securities derived from mortgages became widely accepted in capital markets, and produced high returns. To meet this need, mortgage professionals actively sought customers of lower and lower creditworthiness, (because all of the better credit-risk individuals already had mortgages). Based on traditional mortgage default percentages, brokers and financial professionals felt that the risk of default was quite low, which is what made them so attractive to investors. Unfortu-

nately, these least-qualified buyers were going to prove to default in much higher numbers than predicted. Also, the mortgage-generating institutions were not concerned with the riskiness of the loans, because they were going to sell the loans off to be repackaged, so they would not bear the risk of the loans (Mizen, 2008).

Thus, the risk from mortgage derivatives came from loaning money to people that were poor credit risks, because of an inaccurate assessment of those risks. Because transportation options will not be based on loaning anyone money, the types of problems experienced during the US credit crisis would not seem to be a likely risk for transportation options.

There are two conclusions for us to draw from the credit crisis, however. First, it illustrates that financial professionals are ready to participate heavily in any industry where they believe financial gain may be made by carefully weighing financial risks and returns. Second, when evaluating risks, it is absolutely imperative that the data being used be truly representative of the risks being considered. Another likely outcome of the subprime credit crisis and the more recent LIBOR scandal is that financial derivatives are likely to become more heavily regulated and placed under greater scrutiny. As a result, additional emphasis must be placed on transparency and accountability as we work toward developing transportation derivatives.

We believe that the problems encountered with mortgage-backed securities are unlikely to occur with transportation options. With transportation options, a problem would show up more quickly. If you had hired a bad carrier the feedback from that would be quicker, and no more transactions with that carrier would be created.

Speculation

Speculators’ only interest in the underlying product is its price fluctuation and trying to guess its future direction; they have no need for the actual good. Speculators “play an important

role in the market by providing the liquidity that makes hedging possible and assuming the risk that hedgers are trying to eliminate” (Chance and Brooks, 2007). They provide liquidity by stepping in to buy when there are no other interested parties available. For those speculators, at the strike date, there is no need for the actual product or instrument to change hands: an exchange of money equal to the difference in value is sufficient. Such products are “cash settled.” However, in the case of transportation options, the whole reason companies are interested in the options is to hedge the risk of transportation costs. If capacity is scarce, the call option holder may not be satisfied to receive a payment for the difference between the strike price and the current spot-market price. What they really need and want is the transportation capacity at the negotiated price. However, if a more centralized spot market existed, and the shipper felt confident that it would, in fact, be able to purchase the capacity at the spot market price, the shipper should be willing to accept a cash-settled payment.

Dangers of Options

Options can be very useful instruments. They can be utilized for hedging, speculation, and arbitrage. They also have inherent dangers built into them. Sometimes traders who are supposed to hedge risks can follow an arbitrage strategy that becomes irresponsible speculation. The results of such speculation can be disastrous. Nick Leeson at Barings Bank in Singapore provides an example of this. Mr. Leeson, was an employee of the Singapore office in 1995, and was looking for arbitrage opportunities between the Nikkei 225 futures prices on the Singapore Exchange and those on the Osaka Exchange (Hull, 2008). As he began to speculate, he incurred losses which he was able to hide at first. He then took larger speculative positions to recover the huge losses, but in the end only made the losses worse. The total loss was close to \$1 billion. As a result, Barings Bank, which had operated successfully for 200 years, was put out of business.

Firms must use options carefully and be utilized to hedge risk wisely. Firms could use options to find arbitrage opportunities to reduce transportation cost. Firms have to be careful that they do not cross the line into highly risky market speculation.

STANDARDIZING OPTIONS

An important factor that has made the Baltic Dry Index possible was that ocean shipping routes lend themselves very readily to standardized lanes, given the small number of international ports, as compared to the number of possible origin and destination points for truckload shipments. In order for an active market in options to exist, a standardized set of widely traded options must be created.

Lanes

A set of key lanes could be determined that would be broadly representative of the conditions in the market, in the same way that the S&P 500 or the Dow Jones Industrial Average is widely watched in the stock market. These lanes should probably be some of the highest-volume lanes, freight-wise, but also the ones with the highest volume of options activity. As options trading around transportation has not yet begun, it is not possible to know which lanes will generate the most trading activity. However, it seems likely that the highest-volume freight lanes, shipment-wise, may be among the most actively traded. Demand and supply on transportation lanes are typically asymmetrical. For example, the cost of a truckload originating from Reno, Nevada and delivered to Los Angeles, California is different than the cost of a truckload moving from Los Angeles to Reno. This is because the demand for delivered freight is greater in Los Angeles than it is in Reno.

Off-Lane Origins and Destinations

A convention should be developed regarding how far off of a lane the origin or destination may be for the shipment to still be considered in

the lane. For example, suppose an option from Los Angeles to Chicago is going to be exercised at a price of \$3,000. The distance is roughly 2,000 miles. Suppose the shipper actually wants a delivery made to Kenosha, Wisconsin, 65 miles north of Chicago: Should it be allowed?

A convention for off-lane origins and destinations could to be developed to facilitate option settlement. If a shipper bought a Port of Long Beach to Detroit option, and wants to use it to haul a load from the port to Lansing, Michigan which is approximately 80 miles from Detroit, an agreed upon settlement mechanism to account for the extra distance would need to be developed. Perhaps, this mechanism could be built into the option. For example, for shorter distances, under 500 miles, a maximum of 50 additional miles would be allowed, and for longer distances, a percentage maximum could be allowed. Alternatively, perhaps off-lane points of any distance should be allowed, but a surcharge should be added, related to the distance from the lane to the point.

Cost for Off-Lane Points

If a shipper wants to exercise an option and send the shipment from a slightly different source or to a slightly different destination, it would seem the shipper should pay an additional cost. How much additional should the shipper pay? There are several possibilities. Consider the Los Angeles to Kenosha example mentioned above.

- One solution would be to say that the exercise price of the option is $\$3,000/2000 \text{ miles} = \$1.50/\text{mile}$, and the shipper must pay this additional cost for the distance from Chicago to Kenosha (65 miles): \$97.50.
- Perhaps the shipper should pay \$195, twice the cost of driving from Chicago to Kenosha, to represent the deadhead miles the truck will incur in getting back to Chicago to pick up another load.

- Alternatively, the shipper could argue that when driving from LA to Kenosha, taking the shortest interstate routes, Kenosha is only 30 miles farther from LA than Chicago is. Perhaps the shipper should pay 30 miles of additional distance, plus a 65 mile deadhead charge back to Chicago, \$142.50

At this point, it is not possible to predict which of these policies will be put in place, but it seems that the strongest arguments can be made in favor of the last two policies. Both compensate the carrier for the extra mileage. Shippers would prefer the third option, carriers the second one. Also notice that the same issue arises for origin points which are not right at the specified origin, and a similar policy will need to be implemented for off-lane origins.

Arbitrage

It is important to note that these off-lane costs are important for providing arbitrage opportunities. Arbitrage is when someone finds an unexplained difference between the pricing of two commodities, and takes advantage of the pricing misalignment to profit. As multiple parties exploit the arbitrage opportunity, the price of the under-priced asset goes up, and the price of the over-priced asset goes down, and the arbitrage opportunity ends. In this way, the ability of traders to take advantage of arbitrage opportunities is very important in maintaining the liquidity of the markets.

Off-lane pricing provides for the possibility of arbitrage in the following way. Suppose the price of LA-Chicago is high, and the price of LA-Detroit is low. A shipper could buy the LA-Detroit lane, and pay the off-lane charges to send the shipment to Chicago, and still be cheaper than buying the LA-Chicago lane. As more shippers take advantage of this, the price of LA-Chicago will fall, and LA-Detroit will increase, until the prices are brought into alignment.

Additional Stops

A related issue is whether additional stops along the way may be requested. If some mechanism can be created to allow this possibility, it would increase interest in the options. In some way, the shipper must agree to pay some additional cost for additional stops. This additional cost will probably include:

- An additional cost for each additional stop added to the route
- A cost proportional to the distance the stops add onto the trip length
- A charge per hour required by the stop

At a minimum, the additional costs must be sufficient to cover the carrier's additional labor and fuel costs generated by the stops. Also, the carrier probably would like to maximize the number of loads it can move per week, and would rather not make a lot of stops, and would rather have the cost per stop to be rather high, to serve as a disincentive for shippers to request a lot of stops. For that reason, the cost per mile for the additional distance would likely be higher than the cost per mile of the shipment overall. Perhaps one of the formulas mentioned above will be used. However, it is likely that the cost will be proportional to the total number of miles added to the trip by the stops. The charge for the additional mileage may be some multiple of the cost per mile of the rest of the trip, say 1.5 or 2 times the regular mileage charge. If the shipper is going to request any stops, those would likely need to be specified at the time that the shipper informs the carrier of the intent to use the option.

Timing

To further simplify the trading of common lanes, a convention must be decided upon for the dates of the options. Carriers and shippers alike need to have agreement on the windows when the options can be used. Again, the more standard-

ization that can be brought into the options market, the more efficient the market should be. Also, carriers and shippers do not want to have to keep track of the differing conventions used by different carriers, shippers, or marketplaces. The whole point of transportation options is to reduce uncertainty about future shipments for carriers and shippers. The options must provide enough certainty about the timing of the shipments in order to serve the needs of the shippers, so they can rely on these shipments to meet their needs. Otherwise, there would be no incentive for shippers to use them.

We propose that options be traded for each calendar week of the year, where a week is defined as 12:00 am Sunday to 11:59 pm Saturday ET. For example, a shipper may buy a call option for week 48, to have a guaranteed price for last-minute deliveries before the end of the Christmas selling season.

Another possibility would be that a shipper may seek to purchase options good for any week in a range of weeks, over a 4, 8, or 12 week period. This would give a shipper much more flexibility, but it would place a lot more uncertainty on the carrier, making it much harder for the carrier to plan for the future. Given that the carrier is accepting considerably more risk, these options should carry a much higher risk premium.

Advance Notice (Strike Dates)

Standardization is also required for how much notice the option holder must give before exercising the option. There are several likely possibilities:

- One way would be to say that the decision to use or not use an option must be communicated by 5:00 p.m. on Friday of the prior week, and at that point, the day of the following week on which the option is to be used must be specified, but the final pickup time on that date can be specified later.

- Similarly, the shipper could be required to give notice of intent to use the option by some time, say 5:00 p.m. Friday, and that the actual time (and location) of the shipment must be specified at least 24 hours in advance.

- The final way these could be structured would be to say that the option holder must give at least so many hours of advance notice, perhaps 24 hours. This period of advance notice should be sufficient to allow the carriers to have the necessary equipment in place by the required time.

Some conventions will need to be determined regarding other details of the shipments, for example, regarding holidays. Perhaps the consensus will be that national holidays will be blackout days on which the options cannot be used. Alternatively, they could be treated like regular days, or a surcharge of some percentage, or a fixed dollar surcharge will be added.

Non-Compliance Penalties

If a carrier promises to provide service to a call option buyer, and it fails to deliver as promised, the carrier must face some form of punishment, and the same would hold for the seller of a put option. It would seem likely that this punishment would include a significant financial penalty for the event, and a long-term consequence of being barred from participating in trading either transportation options, or if the trading is taking place on an established exchange such as the Chicago Board Options Exchange, being barred from participating in that exchange in the future. If the firm has too many non-compliance events in a given period of time, SEC involvement may be required. At a minimum, the financial penalty needs to be large enough that no carrier would decide to abandon its obligation, because abandoning it would be cheaper than fulfilling it. The penalty should be large enough to cause carriers to do everything they can do to provide the promised service.

On the other hand, these options will involve large vehicles traveling on public roads. Equip-

ment breakdowns and unforeseeable major traffic situations can happen. If a carrier has taken reasonable and prudent efforts to provide the capacity, but an unforeseeable incident makes the carrier late, the penalties probably should not be draconian.

Premium Services

Separate options should be sold for team and single-driver service on a given lane. As a majority of cross-country loads are single-driver, they will likely represent the majority of interest in options. With a single driver, Los Angeles to Chicago takes four days versus only two for team drivers. However, teams cost 25% more than single driver rate. Some carriers may decide to offer options that could be “upgraded” to other services, like team drivers, or refrigerated loads.

MANAGING TRANSPORTATION OPTIONS

For a company using transportation options, it needs to be able to track and manage those options, and be able to decide when to buy or sell them. The need for options by shippers, carriers and 3PLs will be closely related to their future transportation needs, so any tool for managing options needs access to as much information as possible about those future needs. The most likely solution is for any Options Management System (OMS) to be tightly linked to the company’s transportation management system (TMS), perhaps as a module of the TMS. In the TMS, the OMS will have access to all of the company’s existing future transportation needs and plans. Shippers will want to track the eventual shipments via their TMS, so obviously a linkage between the OMS and the TMS will be important.

Having estimates of future transportation needs for upcoming peak shipping seasons would seem a good way to maximize the benefits of using options. However, many companies may not be making plans very far into the future via their

TMS, so some companies will need to expand their abilities to forecast freight needs to maximize their benefits from options.

CONCLUSIONS AND FUTURE WORK

Transportation options could provide buyers and sellers the opportunity to hedge transportation capacity and cost. As described above, options can provide shippers, carriers and logistics companies a significant opportunity to reduce risks.

We believe that transportation options present an opportunity for supply chain professionals to gain significant advantage in managing supply chain risk. There are, however, numerous issues that remain to be addressed.

Given that the recent credit crisis was exacerbated (if not caused) by the use of derivatives, future developments in transportation options must proceed carefully and earn the industry's trust that these will be a tool to help manage risk, without creating an unforeseen set of new risks for the industry.

Further clarification is needed as to how options should be constructed and traded on an exchange. There are different ways that options could be traded and settled, and these issues need to be decided. More work is also needed to investigate the role of transportation indexes in pricing and settling options contracts.

As identified above, there are numerous areas where buyers and sellers of options need to agree on what the common terms of the options would be. Transportation options need to be standardized. The purpose of transportation options is to reduce uncertainty about future shipments for carriers, shippers, and third parties. Options must provide enough certainty about the timing of the shipments in order to serve the needs of the shippers, so they can rely on these shipments to meet their needs. This standardization is needed to allow options to be widely traded on

an exchange, so future work is needed to identify more clearly what the "standard terms" of a transportation option are likely to look like.

Once the terms of the options are more readily in focus, work is needed to properly value the options. Because of their similarity to financial and commodity options, it is likely that the models and methodologies for valuing transportation options will borrow heavily from the existing financial literature.

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AN EMPIRICAL CROSS CULTURAL ASSESSMENT OF A LOGISTICS/SUPPLY CHAIN MANAGEMENT TYPOLOGY

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ABSTRACT

This manuscript compares the three dimensions (Process Strategy, Market Strategy, and Information Strategy) of the Bowersox Daugherty (1987) logistics strategy typology among five disparate countries by integrating the findings of previous empirical research. The appropriateness of the three Bowersox/Daugherty dimensions when combined into the construct Overall Logistic Strategy (OLS) are assessed. The role of OLS impact on Organizational Competitiveness (COMP) through two intervening variables LCE (Logistics Coordination Effectiveness) and CSC (Customer Service Commitment) is evaluated. The findings indicate that OLS is an appropriate descriptor of logistics/supply chain management in a wide range of cultures and that the integration of OLS, LCE, and CSC is useful in explaining COMP across cultures. The findings of this research are discussed in the context of earlier perspectives on organizational strategy and overall logistics strategy.

INTRODUCTION

The Bowersox/Daugherty (1987) typology has been the subject of study for over twenty years. Previous research has examined that typology in the United State and Canada, longitudinally in the United States, and comparatively in China, Ghana, Guatemala, and Turkey. Because of differences in cultures data collection methodologies have varied. This research posits that the Bowersox/Daugherty typology may be a robust framework for further study of logistics/supply chain management. This work is also useful in addressing the concerns of Luo, Van Hoek, and Ross (2001) that cross-cultural logistics research has lagged. Several recent studies have compared logistics/supply chain management strategies in China, Ghana, Guatemala, and Turkey with practices in the

United States. As a result, the authors believe that the examination of these studies would provide insights into the value of the Bowersox/Daugherty typology as a framework for studying, describing, and explaining logistics/supply chain management across cultures.

This manuscript is organized into seven sections. The first two sections contain the introduction and literature review, and they provide an overview of the conceptual framework for the study. Sections three and four contain the research methodology and data analysis and results. The fifth section discusses the findings while the sixth section presents the authors' conclusions. The final section provides implications for practitioners, teachers and researchers of logistics/supply chain management.

LITERATURE REVIEW

Researchers have found ample data to support the Bowersox and Daugherty (1987) logistics management decision-making typology (Clinton and Closs, 1997; McGinnis and Kohn, 1993, 1997 and 2002; McGinnis, Kohn, and Spillan, 2010). In addition there is an emerging body of research exploring this typology in different cultures (McGinnis, Harcar, Kara, and Spillan, 2011; McGinnis, Spillan, Kara, and Domfeh, 2012; and Spillan, McGinnis, Kara, Yi, 2013). However, there has been no substantive research focusing on the relevance of Bowersox/Daughterty typology in different cultural environments.

Bowersox and Daugherty (1987) completed a comprehensive study of logistics integration in 1987. In this research they identified three distinctly different logistics management strategy types that firms have used in their decision-making. They are summarized as follows:

- The objective of Process Strategy is to manage flows and control activities that “give rise to cost”. In current terminology they are referred to as “cost drivers.”
- The objective of Market Strategy is to reduce the complexity faced by customers. For example, this strategy may try to provide a single point of contact for customers that source multiple products from different divisions, or facilities, of the same firm.
- The objective of Information Strategy is to coordinate information flows throughout the channel of distribution that facilitates cooperation and coordination among channel (supply chain in today’s vocabulary) members.

The three components that comprise the Bowersox/Daugherty typology have been tested by McGinnis and Kohn (1993, 1997 and 2002)

in studies which sampled subjects from large U.S. manufacturing firms. They found that process and market strategies were emphasized when logistics strategies were intense. They also found that both strategies were present at moderate levels when firms used a balanced strategy approach, and both strategies were present only at low levels when firms used an unfocused strategy. These studies indicated that the three dimensions (logistics process strategy, market strategy and information strategy) have an important effect on a firm’s success. They did find that the three dimensions of logistics strategy would be more likely combined rather than used separately as Bowersox and Daughterty (1987) originally intended.

In 1997 Clinton and Closs sampled 818 U.S. and Canadian firms to assess the significance of the Bowersox/Daughterty typology. They concluded that there was a clear overlap of the three strategies (process, market, information) and that this is to be expected because logistics performs the same activities regardless of the overall logistics strategy.

Further research focused on small firms (Spillan, Kohn, and McGinnis, 2010). Small firms are the largest employer of human resources and rely on logistics to accomplish their goals. The authors concluded that the strategies of small and large U.S. manufacturing firms vary in degree more than on type. Market, Process, and Information strategies were present in both small and large firms. In addition, the authors concluded that the logistics strategy outcomes of small and large firms were similar. Finally, it was concluded that the Bowersox/Daughterty typology was applicable to United States manufacturing firms regardless of size.

In recent years there have been three studies of comparative logistics. McGinnis, Harcar, Kara, and Spillan (2011) compared logistics strategies in the United States, Guatemala, and Turkey. In each case confirmatory factor analysis was used to assess the validity of OLS and SEM was used to test the validity of the overall model of OLS-

LCE-CSC-COMP. In all three countries OLS was supported but support for the overall model was mixed, with support for the United States and Guatemalan data but insignificant support for the Turkish data. In another study McGinnis, Spillan, Kara, and Domfeh (2012) compared United States and Ghana data and found that both OLS and the OLS-LCE-CSC-COMP model were supported. Finally, Spillan, McGinnis, Kara, and Yi (2013) compared Chinese and United States data and found the both the OLS and the OLS-LCE-CSC-COMP were supported.

As a result of the findings discussed in the previous paragraphs the authors concluded that an overall assessment of the Bowersox/Daugherty typology's robustness across cultures would be useful. A finding of robustness would suggest that the logistics typology (and logistics/supply chain management strategy) is not very "culturally bound." Conversely, a finding of a lack of robustness would suggest that cross-cultural logistics/supply chain management research should give greater consideration to the cultural issues of each country.

METHODOLOGY

Measures and Questionnaire

Briefly, the study questionnaire had three parts. In the first part, the overall logistics strategy of the companies were measured by three dimensions; process strategy, market strategy and information. Respondents were requested to determine their level of agreement with three statements for process, market, and information strategies for their company /division on a five point -type scale (1 = definitely agree, 5=definitely disagree). The second part of the questionnaire was designed to measure the relationships among logistics strategy constructs that are hypothesized to contribute logistics coordination effectiveness as measured by three statements. Similar Likert scale measures (1 = definitely agree, 5=definitely disagree) in the first section of questionnaire were used in the second section as well. In the third part of the

questionnaire, we included statements to measure customer service commitment and company division competitiveness using the same Likert Scale as previously used in the first and second part of questionnaire.

Data Collection

Bilingual associates translated the designed questionnaire into Turkish, Spanish, and Chinese. To ensure the quality of the translation, we used back translations to check for any discrepancies and translation errors in all countries. The questionnaires were pre-tested with a small group of participants in all countries before it was administrated. In all countries, the results were satisfactory with respect to the meaningfulness and the applicability of the questions in those country environments.

The data for USA was collected in United States manufacturing firms who were affiliates of the Council of Supply Chain Management Professionals (CSCMP) – previously the Council of Logistics Management (CLM). Respondents from manufacturing companies were titled managers or higher in logistics, distribution, or supply chain management and were sampled via mail questionnaires with a pre-notification letter, the questionnaire with a cover letter, and a follow-up letter.

Turkish data was collected by distributing the questionnaire to 500 SMEs (Small-Medium enterprises) operating in the manufacturing industry within the city of Istanbul in Turkey. This sample was selected randomly from the database of the Turkish Small Business Administration (KOSGEB). As of 2008, the KOSGEB database included a total of 12,270 SMEs in Istanbul, which accounts for nearly 28% of all SMEs registered throughout Turkey.

To collect the Guatemalan data, the researchers worked through the Ministry of Economics. Ministry of Economics staff were trained by the researchers on the objective of the questionnaire, what its contents were, how to complete the

survey and how to respond to questions from the respondents. Face-to-face interviews with logistics, distribution and supply chain managers from midsize and large companies located in nine major regional centers in Guatemala were conducted. Considering that the selection of businesses in this large geographic area is a substantial cross-section of the Guatemalan business sector and provides near representativeness of the sample data interviews took place in several different areas including Guatemala City, Escuintla, Villa Nueva, Quetzaltenango, Cobán, Salamá, Chiquimula, Sacatepéquez and Petén.

The Chinese data was gathered under the supervision of a local researcher who is a faculty member at a Chinese university, and is fluent in Chinese and “American” English. The questionnaire was then administered by students to a random sample of a wide variety of organizations, both large state-owned and small and medium enterprises (SME) located over a wide area of firms, mainly in northwest China. A total of three hundred and sixty-one usable questionnaires were obtained.

Data Analysis Approach

The data analysis process followed a five-step approach. First, selected characteristics of the five countries (China, Ghana, Guatemala, Turkey, and the United States) were compared. Inspection of Table 1 indicates that the five countries vary widely in terms of geographical size, population size, percentage of urban population, make-up of their work forces (in percentages in agriculture, industry, and service), GDP size, climate, transportation infrastructure, and public sector corruption. There were no apparent systematic patterns that suggested that there was homogeneity among nations.

Next, the cultural dimensions of the five countries were examined using Hofstede’s Cultural Dimensions (2001). As shown in Tables 2 and 3, there were no systematic patterns of cultural dimensions detected among nations. For example,

a score on Power Distance was not predictive of Uncertainty Avoidance, Individualism/Collectivism, or Masculinity/Femininity.

Taken together, the authors concluded that the five countries were heterogeneous in terms of size, population, economies, climate, transportation, culture, and level of corruption. As a result the authors felt that an assessment of the applicability of the Bowersox/Daugherty typology to these five countries would provide a suitable test for its robustness for studying logistics/supply chain management strategy across cultures.

ANALYSIS AND RESULTS

The first step was to check the construct reliabilities for all three countries. Table 4 shows comparative average construct reliability scores. While several of the reliabilities were below the 0.70 level commonly suggested, the scale items used in our study have been previously used in several studies, have considered having sufficient content validity (Kohn and McGinnis, 1997), and possess adequate levels of reliability.

Further, it was previously concluded that these scores are satisfactory for testing and validating the structure reported in McGinnis, Kohn, and Kara (2011).

Table 5 shows the mean scores for the constructs for all five countries, the results for KMO tests for sampling adequacy, and Bartlett’s test for sphericity for all five countries. These measures are used to determine the suitability of the data for factor analysis. The KMO are 0.832, 0.900, 0.663, 0.770, and 0.823 for the USA, Guatemala, Turkey, Ghana, and China respectively. All levels of significance for Bartlett’s test for sphericity are less than .005. Since all KMO results were above 0.5 (the minimum cut off for factor analysis) and all Bartlett results were $p < 0.0001$ it was concluded that all data was suitable for factor analysis.

TABLE 1
SELECTED COMPARISONS OF
THE UNITED STATES, CHINA, GHANA, GUATEMALA, AND TURKEY

Category	United States	Guatemala	Turkey	Ghana	China
Area (sq km/sq miles)*	9,826,675/3,807,983	108,889/42,042 (Slightly smaller than Tennessee)	783,562/302,533 (Slightly larger than Texas)	238,533/92,435 (Slightly smaller than Oregon)	9,596,961/3,705,383 (Slightly smaller than the United States)
Population* Percentage of Population Urban*	307,212,123 est. 82%	14,373,472 est. 49%	780,694,485 est. 70%	25,199,609 est. 51% (2010)	1,349,585,838 est. 47% (2010)
Make up of Labor Force*	Agriculture: 0.7% Industry: 20.3% Managerial/professional/ technical: 37.3% Sales & services: 41.8%	Agriculture: 38% Industry: 14% Services: 48%	Agriculture: 25.5% Industry: 26.2% Services: 48.4%	Agriculture: 56% Industry: 15% Services: 29%	Agriculture: 34.8% Industry: 29.5% Services: 35.7%
Gross Domestic Product*	\$15.66 trillion est.	\$78.42 billion est.	\$1.125 trillion est.	\$83.18 billion est.	\$12.38 trillion est.
Climate*	Varied	Tropical	Temperate	Tropical	Extremely Diverse
Railroads (km/miles)*	224,792/139,683	332/206	8,699/5398	947/588	86,000/53,439
Paved Roads (km/miles)*	4,374,784/2,718,438	4,863/3022	313,151/194,559	9,955/6,186	3,453,890/2,146,205
2011 Public- sector Corruption Index.	73 Higher number > less corrupt.	33 Higher number > less corrupt.	49 Higher number > less corrupt.	45 Higher number > less corrupt.	39 Higher number > less corrupt.

* Sources

- Categories "Area" through "Paved Roads": United States Central Intelligence Agency World Factbook (www.cia.gov, 2013). Accessed May 28, 2013.
- Categories "2012 Public-sector Corruption Index" (www.transparency.org). Accessed May 28, 2013.

TABLE 2
SUMMARY OF HOFSTEDE'S CULTURAL DIMENSIONS

Dimension Name and Brief Description	Example Attributes of a High Score	Example Attributes of a Low Score
Power Distance: The extent that those less powerful accept that power is distributed unequally.	More concentration of authority, tall organization pyramids, subordinates expect to be told.	Less concentration of authority, flat organization pyramids, subordinates expect to be consulted.
Uncertainty Avoidance: Extent to which members of a culture are comfortable or uncomfortable in unstructured situations.	Uncertainty avoidance. Not comfortable with ambiguity.	Uncertainty accepting. Greater degree acceptance of new ideas, new products, and a willingness to try something new or different.
Individualism and Collectivism: The degree of interdependence a society maintains among its members.	A loosely-knit society where peoples are more likely to look after themselves and their immediate families. Employees are expected to be self-reliant and display initiative.	People are more likely to act in the interest of the group and not necessarily themselves. Relationships are cooperative among in-groups but are cold or hostile to out-groups.
Masculinity and Femininity: The degree a society is "winner-loser" versus "caring for others and quality of life" oriented.	Masculine, the society is driven by competition, achievement and success. Success is defined as winner or best in field.	Feminine, the society has dominate values of caring for others and quality of life.
Long- Versus Short-Term Orientation: The degree to which members of a culture show a pragmatic future-oriented perspective rather than a short-term point of view.	Long-term orientation. Persistence and perseverance are normal. Relationships tend to be ordered by status.	Short-term orientation. Likely to be driven by short-term results, profit and loss statements offered frequently, striving for quick results and "absolute truth" in all matters.

Source: The Hofstede Center (www.geert-hofstede.com). Accessed May 29, 2013. See also Hofstede (2001)

TABLE 3
CULTURAL DIMENSIONS:
A SUMMARY OF AMERICAN, GUATEMALAN, TURKISH, GHANAIAN, AND CHINESE CULTURES

Dimension Index/ Interpretation	United States	Guatemala	Turkey	Ghana	China
Power Distance	40 (Low)	95 (High)	66 (High)	80 (High)	80 (High)
Uncertainty Avoidance	46 (Uncertainty accepting)	101 (Very high uncertainty avoidance)	85 (Uncertainty avoidance)	65 (Uncertainty Avoidance)	30 (Uncertainty accepting)
Individualism/ Collectivism	91 (Individualistic)	6 (Very collectivistic)	37 (Collectivistic)	15 (Collectivistic)	20 (Collectivistic)
Masculinity/ Femininity	62 (Masculine)	37 (Feminine)	45 (Middle)	40 (Feminine)	66 (Masculine)
Long-Term/ Short-Term Orientation	29 (Short-term oriented)	NA	NA	NA	118 (Long-term oriented)

Source: The Hofstede Center (www.geert-hofstede.com). Accessed May 28, 2013. See also Hofstede (2001)

TABLE 4
RELIABILITY SCORES OF INDEPENDENT AND DEPENDENT VARIABLES

		COUNTRIES			
		USA ¹	Guatemala ¹	Turkey ¹	China ³
INDEPENDENT VARIABLES*	Scale items				
	Scale 1: Process Strategy (PROCSTR)				
	1.1. In my company/division, management emphasizes achieving maximum efficiency from purchasing, manufacturing, and distribution.	0.651	0.524	0.856	0.678
	1.2. A primary objective of logistics in my company/division is to gain control over activities that result in purchasing, manufacturing, and distribution costs.				
	1.3. In my company/division, logistics facilitates the implementation of cost and inventory reducing concepts such as Focused Manufacturing and Just-in-Time Materials Procurement				
	Scale 2: Market Strategy (MKTGSTR)				
	2.1. In my company/division, management emphasizes achieving coordinated physical distribution to customers served by several business units.	0.741	0.624	0.894	0.626
	2.2. A primary objective of logistics in my company/division is to reduce the complexity our customers face in doing business with us.				
	2.3. In my company/division, logistics facilitates the coordination of several business units in order to provide competitive customer service.				
	Scale 3: Information Strategy (INFOSTR)				
	3.1. In my company/division, management emphasizes coordination and control of channel members (distributors, wholesalers, dealers, retailers) activities.	0.629	0.739	0.903	0.440
	3.2. A primary objective of logistics in my company/division is to manage information flows and inventory levels throughout the channel of distribution.				
	3.3. In my company/division, logistics facilitates the management of information flows among channel members (distributors, wholesalers, dealers, retailers).				

*Scales: 1 = Strongly Agree, 2 = Agree, 3 = Neither Agree nor Disagree, 4 = Disagree, 5 = Strongly Disagree.

¹McGinnis, Michael A., Talha Hancar, Ali Kara, and John E. Spillan (2011), "Cross-Cultural Validation of the Factorial Structure of a Logistics Strategy Model: A Three Country Study," *Journal of Transportation Management*, Vol.22, No. 2, pp.25-43.

²McGinnis, Michael A., John E. Spillan, Ali Kara, and King Obed Domfeh (2012), "A Comparison of Logistics Strategies and Integration in the U.S. and Ghana," *Journal of Transportation Management*, Vol. 23, No. 1, pp. 27-42.

³Spillan, John E., Michael A. McGinnis, Ali Kara, and George Liu Yi (2013), "A Comparison of the Effect of Logistics Strategy and Logistics Integration on Firm Competitiveness in the USA and China", *International Journal of Logistics Management*, Vol. 24, No. 1. In press.

TABLE 4 (Continued)

Scale items	COUNTRIES			
	USA	Guatemala	Turkey	China
Logistics Coordination Effectiveness (LCE)				
4.1. The need for closer coordination with suppliers, vendors, and other channel members has fostered better working relationships among departments within my company.	0.609	0.733	0.818	0.551
4.2. In my company logistics planning is well coordinated with the overall strategic planning process.				
4.3. In my company/division logistics activities are coordinated effectively with customers, suppliers, and other channel members.				
Customer Service Coordination (CSC)				
5.1. Achieving increased levels of customer service has resulted in increased emphasis on employee development and training.	0.695	0.634	0.830	0.506
5.2. The customer service program in my company/division is effectively coordinated with other logistics activities.				
5.3. The customer service program in my company/division gives us a competitive edge relative to our competition.				
Company/Division Competitive Responsiveness (COMP)				
6.1. My company/division responds quickly and effectively to changing customer or supplier needs compared to our competitors.	0.733	0.532	0.907	0.695
6.2. My company/division responds quickly and effectively to changing competitor strategies compared to our competitors.				
6.3. My company/division develops and markets new products quickly and effectively compared to our competitors.				
6.4. In most of its markets my company/division is a very strong competitor.				

DEPENDENT VARIABLES*

TABLE 5
AVERAGE VALUES OF INDEPENDENT AND DEPENDENT VARIABLES:
USA, GUATEMALAN, TURKISH, GHANAIAN, AND CHINESE FIRMS

Variables	USA Data Average 1990-2008 ¹	Guatemala Data Average, 2010 ¹	Turkish Data Average, 2010 ¹	Ghana Data, 2012 ²	China Data, 2011 ³
1. PROCSR*	2.332	2.245	2.071	3.54	2.24
2. MKTGSTR*	2.541	2.057	2.394	3.36	2.33
3. INFOSTR*	2.769	2.107	2.398	3.42	2.31
Dependent Variables					
1. LCE*	2.580	2.098	2.056	3.34	2.31
2. CSC*	2.5205	2.166	2.461	3.22	2.33
3. COMP*	2.3969	2.1090	2.6157	3.23	2.37
KMO Measure of					
Sampling Adequacy	0.832	0.900	0.663	0.770	0.823
Bartlett's Test of					
Sphericity	0.000	0.000	0.000	0.000	0.000

*Scales: 1 = Strongly Agree, 2 = Agree, 3 = Neither Agree nor Disagree, 4 = Disagree, 5 = Strongly Disagree.

¹McGinnis, Michael A., Talha Harcar, Ali Kara, and John E. Spillan (2011), "Cross-Cultural Validation of the Factorial Structure of a Logistics Strategy Model: A Three Country Study," *Journal of Transportation Management*, Vol.22, No. 2, pp.25-43.

²McGinnis, Michael A., John E. Spillan, Ali Kara, and King Obed Domfeh (2012), "A Comparison of Logistics Strategies and Integration in the U.S. and Ghana," *Journal of Transportation Management*, Vol. 23, No. 1, pp. 27-42.

³Spillan, John E., Michael A. McGinnis, Ali Kara, and George Liu Yi (2013), "A Comparison of the Effect of Logistics Strategy and Logistics Integration on Firm Competitiveness in the USA and China," *International Journal of Logistics Management*, Vol. 24, No. 1. In press.

Confirmatory Factor Analysis

To confirm the underlying factor structure, the authors examined the CFA of all data sets. As shown in Table 6, five indices were used. They were: Chi-square, Root Mean Square Error of Approximation (RMSEA) Goodness of Fit Index (GFI), and Comparative Fit Index (CFI). The two-step approach suggested by Anderson and Gerbing (1988) was used to examine the measurement model and then the structural model. In the measurement model, the hypothesized relationship between the nine logistics strategic orientations and the three first order factors were examined to understand how well the relationships fit the data. In the structural model, we examined the relationship between the three first order factors (PROCSTR, MKTGSTR, and INFSTR).

The results of the estimation of the first order factor model revealed very strong results for all datasets used as indicated by several different measures ($X^2_{USA} = 31.058$, $X^2_{GUATEMALA} = 48.65$, and $X^2_{TURKEY} = 38.40$). As suggested by McGinnis, Kohn, and Kara (2011), we allowed two of the error terms to be correlated. Other fit indices also provided good levels of fit as shown below.

- $RMSEA_{USA} = 0.049$; $GFI_{USA} = 0.962$; $CFI_{USA} = 0.970$
- $RMSEA_{GUATEMALA} = 0.082$; $GFI_{GUATEMALA} = 0.940$; $CFI_{GUATEMALA} = 0.941$
- $RMSEA_{TURKEY} = 0.059$; $GFI_{TURKEY} = 0.962$; $CFI_{TURKEY} = 0.988$
- $RMSEA_{GHANA} = 0.082$; $GFI_{GHANA} = 0.954$; $CFI_{GHANA} = 0.917$; $RMSEA_{CHINA} = 0.014$; $GFI_{CHINA} = 0.985$; $CFI_{CHINA} = 0.995$.

Although X^2 value for two of the datasets were significant at $\alpha < 0.05$, it was not considered to be major concern since the other fit indices showed strong model fit. The authors concluded that the relationships between the items and latent factors were confirmed by the five results obtained from the different countries.

The last step in the process to confirm the underlying structure of the model was to evaluate the relationship between the three first

order factors and a second order factor named “overall logistics strategy.” The purpose here is to understand how the three factors contributed to an overall construct. The results of the second order confirmatory factor analyses for all three datasets showed very good fit indices.

Structural Model

The structural model was used to test the hypotheses of all six factors tested in the measurement model. The conceptualized structural model for five data sets is shown as Figure 1. Inspection of Table 7 revealed that the all linkages were significant and the directions of relationships were as hypothesized for the US, Guatemala, Ghana, and China. Although the model fit is considered acceptable, only one of the hypothesized links for Turkish data was significant as shown in Table 8. It appears, in the case of Turkey, that OLS and LCE did not have any significant influence on CSC. However, CSC had significant influence on competitiveness of Turkish companies.

Overall, the data from all five countries support the conceptualization of the Bowersox/Daugherty typology (See Appendix 1). In addition, data from four of the five countries

support the conceptualized structural model of Overall Logistics Strategy (OLS) > Logistics Coordination Effectiveness (LCE) > Customer Service Commitment > Organizational Competitiveness (COMP), while Turkish data did not support the conceptualized structural model. While this may be due to some other factors not examined in the study, one could speculate that there might be fundamental differences among these constructs in the Turkish market environment. However, the

TABLE 6
SUMMARY OF FIRST ORDER FACTOR ANALYSIS OF OVERALL LOGISTICS STRATEGY (OLS):
USA, GUATEMALAN, TURKISH, GHANAIAAN, AND CHINESE FIRMS

Variables	USA Data Average 1990-2008 ¹	Guatemala Data Average, 2010 ¹	Turkish Data Average, 2010 ¹	Ghana Data, 2012 ²	China Data, 2011 ³
Chi-square	31.058	48.651	38.402	73.991	25.608
p-value	0.095	0.001	0.017	0.000	0.363
CFI	0.970	0.941	0.988	0.917	0.995
GFI	0.962	0.944	0.962	0.954	0.985
RMSEA	0.049	0.082	0.059	0.082	0.014

¹McGinnis, Michael A., Talha Harcar, Ali Kara, and John E. Spillan (2011), "Cross-Cultural Validation of the Factorial Structure of a Logistics Strategy Model: A Three Country Study," *Journal of Transportation Management*, Vol.22, No. 2, pp.25-43.

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TABLE 7
SUMMARY OF FIRST ORDER FACTOR ANALYSIS OF OVERALL LOGISTICS STRATEGY (OLS) AND FIRM
COMPETITIVENESS:
USA, GUATEMALAN, TURKISH, GHANAIAAN, AND CHINESE FIRMS

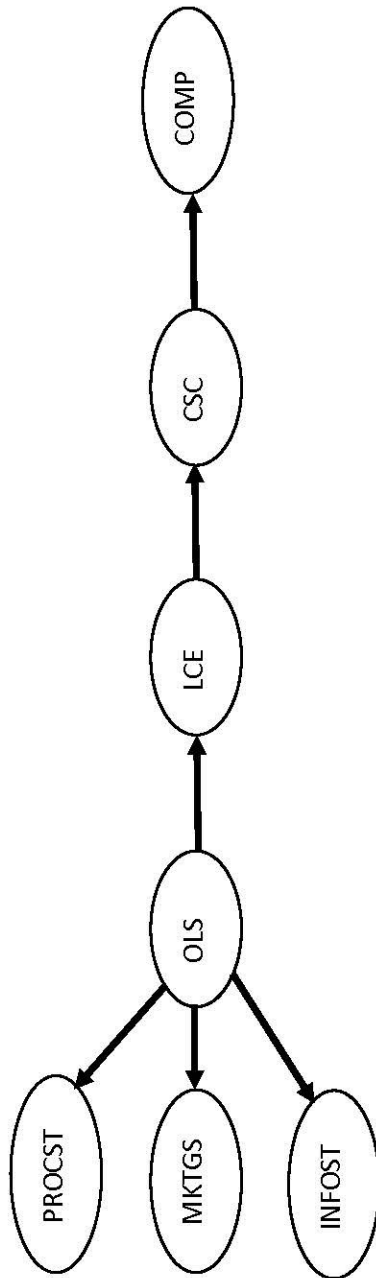
Variables	USA Data Average 1990-2008 ¹	Guatemala Data Average, 2010 ¹	Turkish Data Average, 2010 ¹	Ghana Data, 2012 ²	China Data, 2011 ³
Chi-square	125.971	192.600	170.718	162.867	154.474
p-value	0.022	0.000	0.000	0.000	0.000
CFI	0.960	0.910	0.962	0.935	0.936
GFI	0.916	0.867	0.912	0.941	0.949
RMSEA	0.043	0.081	0.061	0.045	0.040

¹McGinnis, Michael A., Talha Harcar, Ali Kara, and John E. Spillan (2011), "Cross-Cultural Validation of the Factorial Structure of a Logistics Strategy Model: A Three Country Study," *Journal of Transportation Management*, Vol.22, No. 2, pp.25-43.

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FIGURE 1
CONCEPTUALIZED STRUCTURAL MODEL



authors conclude that the agreement on the consistency of direction of the relationships in factor structures in all five datasets and support for hypothesized relationships in four out of five datasets provides persuasive support for (a) the applicability of the Bowersox/Daugherty typology in the assessment of logistics/supply chain management strategy across a wide range of economies and cultures and (b) provides insights into the stages linking logistics/supply chain management strategy to organizational competitiveness. The following section discusses relevance and implications of these results.

DISCUSSION

The perspectives of three earlier writers clarify the roles of logistics/supply chain management in contributing to the competitiveness of organizations. James D. Thompson (1967) modeled the organization as having three layers. First, the Technological Subsystem was most like a closed system that needed to be isolated from the environment in order to perform well on hard measures of performance. This isolation, or buffering, could be achieved via sealing (isolating the organization from the external environment), buffering (stockpiling materials, planned maintenance, training), smoothing (forecasting and reducing fluctuations in sales via scheduling and sales promotions), adapting (planning), and rationing (prioritizing customers, establishing priorities, and setting rules). The second layer is the Institutional Subsystem which deals with the external environment, which is most like an open system that has to respond to generalized, often difficult to measure, norms. This means that the Institutional Subsystem must be able to interact naturally with its external environment with the goal being the long-term well being of the organization. The third layer, the Administrative Subsystem, mediates between the Technological and Institutional subsystems, simultaneously seeking flexibility from the Technological Subsystem (to permit administrative discretion) and commitment from the Institutional

APPENDIX 1
COMPARISON OF RELIABILITY COEFFICIENTS (Alphas) FOR
OVERALL LOGISTICS STRATEGY (OLS):
USA, GUATEMALA, TURKEY, GHANA, AND CHINA

Overall Logistics Strategy (OLS) Variables (from Exhibit 4)		USA	Guatemala	Turkey	Ghana	China
		1990 N = 59 $r^2=0.722$	2010 N = 179 $r^2=0.722$	2011 N = 216 $r^2=0.825$	2012 N = 350 $r^2=0.773$	2012 N = 361 $r^2=0.699$
1.	In my company/division, management emphasizes achieving maximum efficiency from purchasing, manufacturing, and distribution.					
2.	A primary objective of logistics in my company/division is to gain control over activities that result in purchasing, manufacturing, and distribution costs.	1994 N = 91 $r^2=0.812$				
3.	In my company/division, logistics facilitates the implementation of cost and inventory reducing concepts such as Focused Manufacturing and Just-in-Time Materials Procurement.	1999 N = 169 $r^2=0.775$				
4.	In my company/division, management emphasizes achieving coordinated physical distribution to customers served by several business units.	2006 N = 112 $r^2=0.847$				
5.	A primary objective of logistics in my company/division is to reduce the complexity our customers face in doing business with us.					
6.	In my company/division, logistics facilitates the coordination of several business units in order to provide competitive customer service.	2008 N = 49 $r^2=0.789$				
7.	In my company/division, management emphasizes coordination and control of channel members (distributors, wholesalers, dealers, retailers) activities.					
8.	A primary objective of logistics in my company/division is to manage information flows and inventory levels throughout the channel of distribution.					
9.	In my company/division, logistics facilitates the management of information flows among channel members (distributors, wholesalers, dealers, retailers).					

Subsystem (to permit technological achievement). This creates a “paradox of administration” where the organization simultaneously seeks to reduce uncertainty in the short-run in order to score well on technological measures of performance while achieving flexibility in the long run for greater control in a dynamic environment.

These insights from Thompson (1967) provide perspectives on the three components of Overall Logistics Strategy (OLS) and the conceptualized structural model. For example, Process Strategy (PROCSTR) emphasizes the importance of cost management and efficiency, which are primarily Technical Subsystem concerns. Market Strategy (MKTGSTR) focuses on simplifying transactions to reduce complexity faced when doing business with the organization, which might be considered as primarily Administrative Subsystem concerns. Information Strategy (INFOSTR) focuses on cooperation and coordination among channel members, which appears to be primarily an Institutional Subsystem priority. As a result, the role of Overall Logistics Strategy (OLS) can be thought of as being one aspect of managing the “paradox of administration” where its three components (PROCSTR, MKTGSTR, and INFOSTR) interact to balance the need for efficiency and for flexibility. While the generalizations stated in the previous sentences may oversimplify the roles of PROCSTR, MKTGSTR, and INFOSTR, one can begin to see that OLS must constantly balance the need for efficiency and cost management with flexibility and responsiveness in a dynamic organizational environment.

In a similar manner, the insights from Thompson (1967) provide a perspective on the structural model shown in Figure 1. With the exception of the Turkish data, the path coefficients indicate that the $OLS > LCE > CSC$ network contributes to Organizational Competitiveness (COMP). Here, in the authors’ opinion, the primary focus of LCE is on execution (Technical subsystem issue) while CSC is on coordination within the channel (Administration and Institutional

subsystem issues) which enables the firm to respond (COMP) to the external environment.

Shapiro and Heskett (1985) summarized logistics management as characterized by a dichotomy similar to that discussed by Thompson (1967). On one hand the logistics manager must pay attention to the day-to-day details (summarized as tactical, short-term, quantitative, and detailed) while being able to see the big picture (summarized as broad, qualitative, long-term, and strategic). Here the paradox is captured by PROCSTR, MKTGSTR, and INFOSTR. Each has a primary focus on the execution of day-to-day details. However, LCE and CSC indicate that the logistics/supply chain manager not become so focused on the details of PROCSTR, MKTGSTR, and INFOSTR that they cannot respond to the dynamics of the big picture.

Finally, Autry, Zacharia, and Lamb (2008) used the responses of 254 respondents to create their taxonomy of logistics strategy. Their findings identified two logistics strategies that supported the summarization stated in the previous paragraph by Shapiro and Heskett (1985). Autry, Zacharia, and Lamb’s Strategy 1, Functional Logistics Strategy (FL), emphasized maximum efficiency. The emphasis of this strategy includes inventory and order management, order processing, procurement and storage within the firm. Strategy 2, Externally Oriented Logistics Strategy (FOL) emphasized the ability to respond quickly and efficiently to changing needs. FOL’s focus was on inter-firm coordination, social responsibility, strategic distribution planning, and leveraging technology and information systems. Both strategies focused on customer service, operational controls, and transportation management. Here the authors provided a third framework on which to evaluate OLS and the conceptual structural model shown as Figure 1. As a direct comparison, PROCSTR could be classified as relating to FL while MKTGSTR and INFOSTR could be classified as relating to FOL.

In any event, the authors see no inherent conflict between the results of this research and the work of Thompson (1967), Shapiro and Heskett (1985), and Autry, Zacharia, and Lamb (2008). All three provide insights that enhance the understanding of the Bowersox/Daugherty typology. However, the authors conclude that the typology and structural model presented in this manuscript provide a sound model for understanding logistics and supply chain management.

CONCLUSIONS

The purpose of this study was to explore whether the Bowersox/Daugherty typology is a useful instrument for examining logistics strategies in countries of different sizes, cultures, and economic systems. With logistics/supply chain management as a major component in business activity, it is imperative that managers understand the role logistics/supply chain management play in achieving organizational competitiveness (COMP) as part of the overall efforts of the firm. While a wide range of other strategy considerations (such as product features, promotional activities, pricing decisions, channel of distribution choices, and technological capabilities) play major roles in competitiveness, it is crucial that the role logistics/supply chain management plays in the overall organizational strategy be fully understood. With supply chain management at the center of business activity, it is imperative that managers find and use new ideas that will help them become more competitive in highly competitive markets. Finding new insights into how they can manage their manufacturing and supply chains is essential for goal attainment, profitability and sustainability.

The Bowersox/Daugherty typology provides a useful instrument for examining logistics/supply chain management strategies in a wide range of countries regardless of the geography, the characteristics of the population, the nature of the economy, the culture, and the level of corruption. While this statement may not be

universally true in all situations, the results presented in this manuscript indicate that OLS>LCE>CSC>COMP is applicable in a wide range of situations when conducting comparative research into logistics/supply chain management in a wide range of cross-cultural scenarios. The extent to which this conclusion holds will be supported or revised by future research.

IMPLICATIONS

The research synthesized in this manuscript has logistics/supply chain management implications for practitioners, teachers, and researchers. Because the Bowersox/Daugherty typology, presented as Overall Logistics Strategy (OLS) has been successfully used as a framework for research into logistics/supply chain management over time and in comparative culture research using an array of data gathering methodologies it is robust. This means that the insights gained from the typology should be useful with a wide range of audiences. For practitioners, the concept of OLS>LCE>CSC>COMP provides a straightforward framework for understanding logistics/supply chain management as part of the overall management of the firm and as a tool for explaining that process to those in other areas of the organization. The concept is also useful for orienting those new to logistics/supply chain management at the entry, middle, and upper management levels so that they develop an understanding of its context.

For those teaching in logistics/supply chain management, the OLS>LCE>CSC>COMP concept provides a generalized framework that provides a foundation for the specific topics offered at the entry, advanced, MBA, and graduate levels. The importance of understanding the dichotomy of logistics/supply chain management, discussed earlier, provide a framework for helping students at all levels understand the “paradox of administration” as it applies to this area of expertise.

For logistics/supply chain management researchers, the Bowersox/Daugherty typology provides a framework that has been successfully used in research for over twenty years. While there are other models that may be useful, the robustness of this typology provide one basis for comparing future research results with previous work.

Future research into logistics/supply chain management should seek opportunities to explore practices in other countries/cultures. Little is known of comparative logistics/supply chain management in the various countries of Asia and the subcontinent of India. Further, logistics and supply chain management practices, and their impact on customer service and organizational competitive responsiveness have not been systematically studied. In addition, research into logistics and supply chain management may benefit from expanding the understanding of logistics/supply chain management decision making by including antecedents and moderating factors (such as competition, market turbulence, and differences in business environment) into the design. Finally, further study of logistics/supply chain management in other nations/cultures could be gained by examining the relevance of the Bowersox/Daugherty typology in nonmanufacturing industries including retailing, healthcare, financial services, transportation firms, and food service. These industries may provide a different perspective on the process, market, and information strategy in their different environments.

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Journal of Transportation Management

Guidelines for Submission/Publication

GENERAL

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2. Articles should be submitted electronically to Dr. Taylor at taylorjohn@wayne.edu.

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$$y = a + 1x + 2x + 3x + ax$$

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Coyle, John J., Bardi, Edward J., and Novack, Robert A. (2004), *Transportation*, 6th ed., Cincinnati, OH: South-Western College Publishing.

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MANUSCRIPT SAMPLE

A FRAMEWORK FOR EVALUATING SUPPLY CHAIN PERFORMANCE

Terrance L. Pohlen, University of North Texas

ABSTRACT

Managers require measures spanning multiple enterprises to increase supply chain competitiveness and to increase the value delivered to the end-customer. Despite the need for supply chain metrics, there is little evidence that any firms are successfully measuring and evaluating inter-firm performance. Existing measures continue to capture intrafirm performance and focus on traditional measures. The lack of a framework to simultaneously measure and translate inter-firm performance into value creation has largely contributed to this situation. This article presents a framework that overcomes these shortcomings by measuring performance across multiple firms and translating supply chain performance into shareholder value.

INTRODUCTION

The ability to measure supply chain performance remains an elusive goal for managers in most companies. Few have implemented supply chain management or have visibility of performance across multiple companies (Supply Chain Solutions, 1998; Keeler et al., 1999; Simatupang and

Sridharan, 2002). Supply chain management itself lacks a widely accepted definition (Akkermans, 1999), and many managers substitute the term for logistics or supplier management (Lambert and Pohlen, 2001). As a result, performance measurement tends to be functionally or internally focused and does not capture supply chain performance (Gilmour, 1999; *Supply Chain Management*, 2001). At best, existing measures only capture how immediate upstream suppliers and downstream customers drive performance within a single firm.

Table 1 about here

Developing and Costing Performance Measures

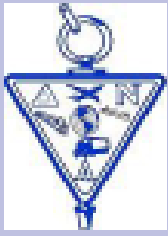
ABC is a technique for assigning the direct and indirect resources of a firm to the activities consuming the resources and subsequently tracing the cost of performing these activities to the products, customers, or supply chains consuming the activities (La Londe and Pohlen, 1996). An activity-based approach increases costing accuracy by using multiple drivers to assign costs whereas traditional cost accounting frequently relies on a very limited number of allocation bases.

$$y = a^2 - 2ax + x^2$$

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